Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

50X1-HUM

Page Denied

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

50X1-HUM

АРУ-2А AUTOMATIC SYSTEM

TECHNICAL DESCRIPTION
OPERATING AND MAINTENANCE
INSTRUCTIONS

SECRET

NOFORN

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

50X1-HUM

C O N T E N T S

	Page
Section I. Description of the APY-2A Automatic Booster System	5
Purpose	5
Specifications	7
Outfit	10
Design and Principle of Operation	11
Design of the APY-2A Control Unit and Its Components	32
Arrangement, Principle of Operation and Design of Separate Elements of the APY-2A Control Unit	39
Section II. Operating and Maintenance Instructions	68
Mounting on Aircraft	68
Operation	71
Possible Malfunctions and Corrections	75
Maintenance of the APY-2A Control Unit	84
Maintenance, Fault-Finding, Disassembly, Assembly, Adjustment and Testing of the Booster System Components	89
Assembly of the APY-2A Control Unit	118
Adjusting the Automatic System	124
Testing the APY-2A Automatic Booster system	131
Section III. Technical Description of the APY-2A Position Indicator	185
Purpose	185
Specifications	185

SECRET

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Outfit 186
Design and Principle of Operation 186
Design 187
Operation and Maintenance Instructions 188

Appendices
I. Flushing, Packing and Storage Instructions for the APY-2A Automatic Booster System . . 193
II. Conversion Table of Excess Pressure for MPД-10C Transmitters 195
III. Device for Adjusting and Testing the Automatic Booster System 196

50X1-HUM

Section I

DESCRIPTION OF THE APY-2A AUTOMATIC SYSTEM

PURPOSE

The automatic system of the APY-2A variable ratio boost unit is employed in the aircraft pitch control to change automatically the stick-to-stabilizer link ratio thereby weakening the effect of different flight conditions on the aircraft manoeuvrability. This power-assisted control is subordinated to a special nonlinear adjustment law which is actually a function of two variables: impact pressure and aircraft flight altitude. In addition, this adjustment law depends on the aircraft aerodynamics and the pilot's tolerance.

The APY-2A automatic system ensures uniform flight techniques by increasing the stick force and loading and providing bigger leverage per degree of the stabilizer deflection as the indicated airspeed increases and the flight altitude decreases.

Within the assigned altitudes the automatic system operation is governed by both impact pressure and flight altitude.

The working cycle of the automatic system is based on the compensation for the effect of high differential impact pressures and variations in the aircraft aerodynamic performance with a Mach number higher than 1.0 on the aircraft stability in pitch.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

When flying at altitudes below the assigned the automatic system operates only from impact pressure.

At altitudes above the assigned the automatic system maintains constant link ratios irrespective of the change in impact pressure and flight altitude.

At impact pressures during take-off, landing and circling over the airfield at all altitudes the automatic system is set for the take-off-and-landing position.

The APY-2A automatic system is a self-contained assembly picking up dynamic and static pressures from the aircraft nose airspeed tube (ПВД); when in good condition, it requires no attention of the pilot thus enabling him to utilize the aircraft manoeuvring potentialities to the better advantages.

The automatic system follows the preset cycle of operation by intermittent engagements, whose number within the range of control by impact pressure and flight altitude is so selected as to produce a minimum effect on the pilot in flight and relieve the automatic system relays of excessive strain.

In case of a faulty control unit the pilot can operate the APY-2A servomechanism manually by directly switching on the electric motor of the servomechanism drive.

The position and functioning of the APY-2A automatic system in flight are checked by a take-off and landing warning lamp and an indicator with a scale marked off to read in km/hr and in metres of flight altitude. The indicator shows the values actually followed-up by the APY-2A servomechanism.

The external view of the APY-2A automatic system is shown in Fig. 1.

SPECIFICATIONS

Application

The APY-2A automatic system is designed to operate in the following conditions:

Ambient temperature	
for booster automatic unit	from -(50-55)°C to +90±5°C
for control unit and position indicator	from -(50-55)°C to +50°C
Ambient temperature changes from -50°C to +90°C for automatic unit (servomechanism) within	10-20 min.
Relative humidity of ambient air	up to 98%
Attachment parts of automatic unit APY-2A (servomechanism) vibrate	from 10 to 200 c.p.s. with amplitude from 0.5 to 0.022 mm which conforms to acceleration up to 3.5 g
Attachment parts of control unit APY-2 and position indicator vibrate.....	from 10 to 80 c.p.s. with amplitude from 0.5 to 0.047 mm which conforms to acceleration up to 1.1 g
Short-time shake of attachment parts	from 40 to 100 shocks per minute, with amplitude conforming to acceleration of 4 g

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Linear accelerations ..... up to 8 g

Main Technical Characteristics

Rated voltage ..... 28±0.5 V

Consumed current ..... maximum 13 A

Arm of the automatic unit (servo-mechanism) to the booster, with atmospheric pressure in the static cavity of the MPД-106 and MPД-126 potentiometer transmitters and a surplus pressure in the dynamic cavity of the MPД-106 potentiometer transmitter of 80-95 mm Hg should be ..... 95-99 mm

When the rod is changed over from the smaller to the bigger arm, the arm of the automatic unit (servo-mechanism) to the booster (95-99 mm) should be adjusted at a pressure in the dynamic cavity of the MPД-106 transmitter ..... not below 65 mm Hg

Arm of the automatic unit (servomechanism) to the booster at a pressure in the dynamic cavity of the MPД-106 transmitter of 320-350 mm Hg and with atmospheric pressure in the static cavity of the MPД-126 and MPД-106 transmitters should be ..... 49 - 53 mm

Arm for an altitude of 9650-10,350 m, at the end of stroke should be .... minimum 93 mm

Number of on-off positions of the MУ-100AП electric motor with atmospheric pressure in the static cavity of the MPД-106 and MPД-126 transmitters and a slow (in 60-90 sec.) pressure variation in the dynamic cavity of the MPД-106 transmitter from 80-95 mm to 320-350 mm Hg and reversely at a unilateral pressure variation should be ..... minimum 18

Number of on-off positions of the MУ-100AП electric motor within the assigned altitude range should be within ..... 13 - 47

Accuracy of the system with an altitude variation and a constant dynamic pressure in the MPД-106 transmitter of 320-350 mm Hg should ensure a correct follow-up of the altitude drop to ..... maximum 350 mm

The automatic unit (servomechanism) should shift the servo rod from any initial position to simulate the pressure variation in the dynamic cavity of the MPД-106 transmitter (with atmospheric pressure in the cavity of the MPД-106 and MPД-126 transmitters) within the pressure range from 80-95 mm Hg to 320-350 mm Hg by ..... 5 - 15 mm Hg

Dependence of the automatic unit (servo-mechanism) rod stroke on pressure within the control range should be.. linear

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Time of the servo rod travel from one extreme position to the other without load on the servo rod and with manual control should be:
at ambient temperature of +20°C ..... maximum 4 sec.
at ambient temperature of -(50-55)°C ..... maximum 10 sec.
Operating duty ..... by pulses

Note: In individual cases the assigned height of the arm to the booster can be readjusted by the servo rod with maximum two reverse engagements and maximum eight readjustments when the adjustment law is ensured in the following conditions: increase in impact pressure from 80-95 mm to 320-350 mm Hg; increase in altitude from 5000±300 m. to 10,000±350 m.; drop in altitude from 10,000±350 m. to 5000±300 m. and drop in impact pressure from 320-350 mm to 65 mm Hg.

The automatic system ensures normal adjustment law at the power supply of ..... 28±0.5 V

Note: At a power supply of 27±10% the automatic system ensures the adjustment law with deviations which do not hamper flight. The automatic system derives power from a generator with a voltage regulator acting jointly with a storage battery of a 23 A/hr minimum capacity.

Weight of the APY-2A automatic system (in set) ..... maximum 9 kg
Weight of the control unit ..... maximum 3.6 kg

OUTFIT

The APY-2A automatic system set includes:
automatic unit APY-2A (servomechanism);
control unit;

position indicator APY-2;
certificate filled in and signed.

WARNING. The APY-2A accessories are uniform in electrical characteristics. Except for the position indicator, they can be replaced only by the Manufacturer or in stationary workshops after bringing their output parameters into coordination. Position indicators are interchangeable.

If the servomechanism or the control (resolver) unit fails during operation, replace the entire assembly.

DESIGN AND PRINCIPLE OF OPERATION

General

The APY-2A variable ratio boost control unit is an electromechanical system composed of individual units located in various compartments of the aircraft and interlinked by a common electric circuit.

The control (resolver) unit - the command element of the entire system - is arranged in the aircraft pressurized cockpit. Such arrangement is essential since in a pressurized cockpit the altitude drop in flight is smaller than the probable variation range of altitudes.

In addition, a pressurized cockpit is distinguished by a lesser temperature difference than other compartments of the aircraft.

Therefore, as distinct from other compartments, the pressurized cockpit provides for more favourable and stable operating conditions for the sensitive elements and the relays in the control unit.

The servomechanism changing the linkage ratios in the pitch control system is arranged outside the pressurized cockpit in the rear fuselage and is a part of the common linkage.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

The position indicator showing visually whether the automatic system correctly simulates the set cycle of operation is located on the shock mounted section of the pressurized cockpit instrument board.

The skeleton diagram of the APY-2A automatic system, represented in Fig. 2, shows the schematic layout of the units and their linkage. In addition to the control (resolver) unit, the servomechanism and the position indicator the skeleton diagram shows warning (green) lamp and the manual control switches. The lamp and the manual control switches do not form part of the APY-2A set and are independent elements of the aircraft electric circuit.

The operating APY-2A automatic system is subjected to the action of impact and static pressures which are taken from the aircraft airspeed tube.

The impact and static pressures are fed to the transmitters located in the control (resolver) unit. The value of the control (command) signals produced in the control unit depends on the impact pressure and the flight altitude as well as on the adjustment cycle. The signals induce the servomechanism to shift accordingly the servo rod and also send off receipt signals (feedback) to the control unit. As the servomechanism shifts the rod, it sends respective signals to the position indicator and the warning lamp on the cockpit instrument board thus providing the pilot with a visual reading that the assigned adjustment cycle is followed-up correctly.

If the automatic system control lines are faulty or the assigned cycle of adjustment is disturbed the pilot can switch off these lines and operate the servomechanism manually by means of push switch provided in the cockpit.

When the servomechanism is controlled manually the position indicator and the warning lamp circuits continue to operate. Since the position indicator scale is marked

off to read in km/hr of indicated airspeed and in metres of flight altitude, the pilot can employ the manual system to adjust the servomechanism to the optimal position in keeping with the preset sequence.

Failure of the automatic and manual control circuits involves certain flight restrictions specified in the pilot's instructions.

The APY-2A servomechanism is connected to the aircraft and kinematic pitch control system as shown in Fig. 3.

The body of the servomechanism suspended from a hinge line in the fuselage supports an electric motor which shifts the rod from one extreme position 1-3 to the other 2-4 (See Fig. 3). As the rod shifts from position 1-3, arm H_1 of the servomechanism to the booster decreases and with the rod in position 2-4 drops to H_2. When the stick covers its entire travelling range, from stop to stop, and the arm of the servomechanism to the booster is equal to H_1, the booster deflects the control through the maximum angular range. With the stick travelling range being the same and the servomechanism to the booster arm being equal to H_2, the control is deflected through a lesser angular range. The ratios between the angular deflection ranges of the controls are proportional to the ratio of arms H_2:H_1 and in the APY-2A system relate to each other as 1:2.

When the servo rod is in position 1-3 and the maximum rod arm to the booster relative to the hinge line is equal to H_1, the rod arm to the artificial feel mechanism equals H_3. When the rod arm to the booster is equal to H_2, the arm to the artificial feel mechanism increases and reaches H_4.

When the stick is deflected, the servomechanism-to-artificial feel mechanism arm determines its force. Fig. 3 shows that when the angular range is maximum (arm to booster = H_1), the stick force is minimum since, in this case, the arm to the artificial feel mechanism is $H_3 < H_4$.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

On the other hand, when the angular range is minimum (arm to booster = H_2) the stick force is maximum (arm to artificial feel mechanism $H_4 > H_3$).

Adjustment Cycle

The controllability of high-performance aircraft depends mainly on the following three factors:

(1) The value of impact pressure equal to

$$q = \rho \frac{V^2}{2} = \rho \frac{a^2}{2} M^2 \ (kg/m^2),$$

where ρ is air density at flight altitude ($kg\ sec^2/m^4$);
V = flight speed relative to air (m/sec.);
a = speed of sound at flight altitude (m/sec.);
M = Mach number equal to $\frac{V}{a}$.

The values "ρ" and "a" for different altitudes are given in special standard atmosphere tables.

As can be seen from the equation for impact pressure at low altitudes near the ground (air density is maximum and the speed of sound minimum), high values of impact pressure are attained with the Mach number below 1.0, i.e. at subsonic speeds.

As impact pressure increases at flight subsonic speeds the pitch control system gains in efficiency and a manoeuvre requiring the same effort is executed by deflecting the controls to a magnitude inversely proportional to impact pressure, i.e. the greater the impact pressure, the smaller the movement.

(2) The value of the aircraft static stability proportional to the distance between the aircraft centre of gravity and the point of application of the resultant of the lift force increment (aerodynamic centre). When the Mach

number is small, this distance is constant. As the Mach number rises to high subsonic values (M→1) and particularly at supersonic speeds (M > 1) this distance sharply increases due to the displacement of the aircraft aerodynamic centre, the aircraft stability improves and the execution of a manoeuvre requires a correspondingly greater deflection of the controls.

The displacement of the aircraft aerodynamic centre, its departure from the centre of gravity, is different for various types of aircraft and depends on their aerodynamic characteristics.

As is seen from the above equation for impact pressure at low altitudes and high flying speeds high values of impact pressure can be attained when the Mach number is subsonic.

To illustrate, with the impact pressure in flight near the ground $q \approx 3900\ kg/m^2$, the Mach number ≈ 0.74, i.e. the flying speed at this value amounts to 0.74 of the speed of sound at this altitude. Therefore, the effect of the aircraft improved stability due to displacement of the aerodynamic centre is little felt at low altitudes and the decisive role is played by impact pressure.

At medium altitudes (8000 - 10,000 m.), as can be seen from the equation for impact pressure, the values of impact pressure being the same, the Mach number considerably exceeds 1.0, i.e. the flying speed becomes supersonic.

With impact pressure of $q \approx 3900\ kg/m^2$ at an altitude of 10,000 m., the Mach number ≈ 1.44, i.e. the flying speed at this value amounts to 1.44 of the speed of sound. Simultaneously, there is a considerable improvement in the aircraft stability due to the departure of its aerodynamic centre from the centre of gravity. The deflection of the controls required for the execution of a manoeuvre of the same intensity likewise sharply increases.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

(3) The efficiency of the controls whose importance somewhat diminishes as the Mach number increases. Therefore, as the Mach number grows the controls should be likewise deflected more due to the partial loss of their efficiency. Like an increase in stability, the loss of the controls efficiency at the same impact pressure manifests itself weaker at low altitudes and greater at high altitudes in supersonic flight.

The effect of all these three factors on the manoeuvrability of a high-performance aircraft is represented graphically in Fig. 4 which gives only a qualitative idea of this complicated phenomenon.

Fig. 4 shows that at the same high impact pressure q_1 the deflection of the control stick linearly connected with the deflection of the controls essentially depends on the flight altitude. Therefore, fundamentally different manipulations are required as the flight conditions change. At low impact pressures q_2 the flight altitude practically has no effect on the controllability of the aircraft and the flight techniques.

When flying at high values of impact pressure near the ground and due to small deflections of the control surface necessary for manoeuvring, the aircraft requires more accurate control and the flight technique becomes more complicated. At low values of impact pressures at all altitudes as well as at high values at medium altitudes, the aircraft becomes difficult to control due to greater deflection of the control stick.

To provide for more uniform flight techniques and to reduce the effort required of the pilot, the change in the controllability at different speeds and altitudes of flight should be compensated for.

Fig. 4 shows that to compensate for the effect of the flight conditions on the aircraft controllability the auto-

matic system preset adjustment cycle should provide for two variables - impact pressure and flight altitude.

The adjustment of the APY-2A automatic system is set so that at low altitudes up to 5000 m. where high Mach numbers effect but little the aircraft manoeuvrability the control is governed by impact pressure.

The adjustment cycle by the impact pressure is illustrated in Fig. 5. At impact pressure q_1 at low altitudes where the required deflection of the control surface is negligible the servomechanism-to-power booster arm diminishes and the deflection of the stick per degree of the stabilizer deflection increases as $\frac{H_1}{H_2}$, i.e. approximately twofold.

Simultaneously, the servomechanism-to-artificial feel mechanism arm grows and increased force is added to the stick.

As a result, the pilot need not apply greater effort to the stick since the deflection angles of the control lessen.

Within the range of impact pressures from 0 to q_2 no control is necessary. This impact pressure range corresponds to the speeds for take-off, landing and circling the airfield.

In this case the rod position of the servomechanism to the booster is H_1 and to the artificial feel mechanism, H_3 (See Fig. 3). This position is characterized by the maximum angles of deflection of the control surface and the minimum stick loading and is called the position for take-off and landing. In this position the servomechanism switches on the green warning lamp on the cockpit instrument board. As impact pressure increases the servomechanism-to-booster arm diminishes, the warning lamp goes out and at q_1 the arm jerkily decreases to $H_2 \cong 50$ mm. When pressure changes from q_2 to q_1 the number of on-off positions should be minimum 18. Every engagement causes the servo rod to move approximately by 2 mm.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

At high flying speeds impact pressure suffers air compressibility effects. While examining the dependence of the controllability characteristics on the speed and altitude of flight the following equation for impact pressure (in m^2) was given:

$$q = \frac{\rho V^2}{2} = \frac{\rho a^2}{2},$$

This value of impact pressure is closely related to all aerodynamic dependences and ratios. On the other hand, impact pressure equals

$$q = P_{dyn.} - P_H,$$

where $P_{dyn.}$ is total (dynamic) pressure in the dynamic vent of the airspeed tube (kg/m^2);

P_H - static (atmospheric) pressure of air at the flight altitude (kg/m^2) equal to the pressure in the static chamber of the airspeed tube.

Due to the effect of air compressibility at high flying speeds the air density before the airspeed tube increases as the flying speed approximates the speed of sound. Therefore, with the flying speed approximating the speed of sound, and the value $q = \rho \frac{V^2}{2}$ remaining unchanged, the impact pressure (taking into account the air compressibility) designated as $q_{com.} = P_{dyn.\ com.} - P_H$ increases, due to the greater $P_{dyn.com.}$ At subsonic flying speeds $q_{com.}$ (in mm Hg) is found from the following formula:

$$q_{com.} = P_{dyn.com.} - P_H = P_H \left[1+0.13332\times10^{-6}V^2\right)^{3.5}-1\right],$$

where P_H is the static pressure at an altitude H = 0 m. in kg/m^2 and V is the flying speed in km/hr.

At supersonic flying speed, $q_{com.}$ (in mm Hg) is computed from another formula which accounts for the change both in total (dynamic) and static pressures after the shock wave arising before the airspeed tube.

$$q_{com.} = P_{dyn.com.} - P_H = P_H \left[\frac{0.8584\times10^{-6}V^7}{(V^2-214277)^{2.5}} - 1\right],$$

where the same designations are used as in the preceding formula.

Impact pressure $q_{com.}$ is greater than q, compressibility being disregarded. The difference between them grows as the speed and altitude of the flight increase and near the ground reaches 600 kg/m^2 at a speed of 915 km/hr and 1700 kg/m^2 at 1135 km/hr. At altitudes over 0 the difference between q and $q_{com.}$ increases further.

The KVC-2A booster system picks up the impact pressure with due account of air compressibility, i.e. it operates on the physical pressure which enters the airspeed tube and considerably differs at high altitudes from impact pressure with no allowance made for the compressibility factor.

The KVC-1200 and KVC-2000 speed indicators are so calibrated that as the instrument picks up $q_{com.}$ the broad pointer indicates speed which would be attained without the compressibility effect.

Thus, the speed indicators are calibrated with due allowance for the compressibility factor. The same correction is incorporated in the divisions of the speed scale of the APY-2A automatic system indicator but the receivers taking over impact pressure in the control (resolver) unit react to the physical value of impact pressure, i.e. to the above value with the compressibility factor. Therefore, the

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

difference between q and $q_{com.}$ is properly accounted for in the APY-2A adjustment cycle. The relation between the readings of the speed indicator broad pointer, impact pressure q and impact pressure $q_{con.}$ is shown in Fig. 6 for an altitude equalling 0.

In Fig. 6 showing tolerances for the preset sequence, the speed values read from the indicator broad pointer correspond to definite values of impact pressure with due account taken of compressibility. As has been shown above, at altitudes above 0 the difference between q and $q_{com.}$ continues to increase.

At medium altitudes (from 5000 to 10,000 m.) control by impact pressure alone is ineffective. Due to an increasing Mach number the deflections of the stabilizer necessary for the execution of a manoeuvre of the same intensity, also increase at these altitudes proportionally to impact pressure rise. Therefore, at altitudes of 10,000 m. and higher the automatic system maintains constant arms to the booster H_1 and the artificial feel mechanism H_3 (See Fig. 3).

Within the range from 5000 to 10,000 m. the automatic system maintains the arms to the booster and the artificial feel mechanism in intermediate position.

It follows, therefore, that within the range from 5000 to 10,000 m. the APY-2A automatic system is governed both by impact pressure and flight altitude. The account taken for the flight altitude in the APY-2A adjustment cycle is called altitude correction.

The adjustment cycle with due allowance made for the altitude is presented in Fig. 7. It can be seen that with the impact pressure increasing at an altitude of 10,000 m. the link ratios remain the same; at 7000 m. the automatic system is first governed by impact pressure until $q = q_3$ and then maintains the constant arm $H = H_3$.

At constant values of impact pressure q_1 and at an altitude over 5000 m. the servo rod shifts from position H_2 and at 10,000 m.

reaches H_1. With impact pressure q_3 at 7000 m. an increase in the altitude to 10,000 m. will likewise cause the servo rod to assume position H_1.

These movements of the servo rod varying the linkage ratios of the APY-2A system compensate for the change in the aircraft controllability due to a greater Mach number.

Due to peculiarities of the electric circuit which automatically produces the required servomechanism arm the altitude correction will keep the rod in the given position within a certain tolerance margin. The tolerance margins for altitude correction and for the assigned adjustment by impact pressure are shown in Fig. 8.

In Fig. 8 the tolerances for the arm of the servomechanism to the booster include two margins: for the beginning and the end of the automatic system operation.

This is explained by the fact that the automatic system keeps to the adjustment law during increase and decrease of the impact pressure with a certain lag, i.e. a shift relative to each other. This shift is known as the hysterisis loop.

The tolerance margin for the beginning and the end of the automatic system work is predetermined by the beginning of the hysteresis loop within the adjustment law.

As has been stated above, the preset adjustment cycle is controlled by means of a green warning lamp mounted on the cockpit instrument board and also by the position indicator of the servomechanism rod.

The warning lamp indicates only the take-off-and-landing position of the servomechanism. All other positions of the servomechanism conforming to the preset adjustment cycle sequence are controlled by the position indicator.

The position indicator scale is marked off in km/hr of indicated airspeed and in metres of flight altitude above sea level at P_o=760 mm Hg and a temperature of +15°C. It should be borne in mind, therefore, that the readings of the BA-20 and other navigational aids adjusted before

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

take-off to zero altitude and to the day static pressure on the airfield may essentially deviate (up to ±1500 m) from the readings of the АРУ-2 indicator. These deviations are caused by the АРУ-2А automatic system being tuned to the preset adjustment cycle in the standard conditions H=0. However, the actual flight conditions may essentially differ from the standard ones. It is important to note that the possible difference in the readings of the АРУ-2 indicator and the navigational aids (ВД and, to a lesser degree , КУС speed indicator) by no means testifies to the faulty following-up of the preset adjustment cycle by the automatic system. Variations in the aircraft aerodynamic behaviour are bound up with the change in the Mach number and impact pressure in the equation

$$q = \frac{\rho v^2}{2}$$

Observance of the adjustment law in altitude correction for P_H (static pressure) will automatically account for the change in the speed of sound due to deviations of the air density at the given altitude from standard values and, hence, account for the change in the Mach number at the same flying speed.

As is seen from the above, the АРУ-2 indicator markings serve only to give the pilot a general idea of the correctness of the adjustment cycle simulated by the automatic system.

The operation and use of the АРУ-2 indicator in flight are illustrated in Fig. 9.

Block Diagram

The АРУ-2А automatic system functions as an electric on-off servo utilizing the principle of a nonlinear dependence between the starting torque and the mismatch angle. The servo-

system is operated to move the axle of the control surface to a certain angle and hold it immobile. The starting torque is independent of the mismatch value since the electric motor is switched on by means of auxiliary relays.

The block diagram is shown in Fig.10.

The sensitive elements of the system are type МРД-106 and МРД-126 potentiometer transmitters which pick up respectively dynamic and static pressures from the airspeed tube and transform them into electric current.

The electric current produced by the transmitters is summed up in the РПС polarized relay which transmits an appropriate command to the winding of one of the auxiliary relays РС-3 cutting in one of the РРТ-40 relays. From the РРТ-40 relay contacts current is fed to the servomechanism electric motor. The rotating electric motor actuates the rod of the servomechanism and the slides of the feedback and signalling potentiometers. The slide of the feedback potentiometer sends current to the РПС polarized relay thus effecting position feedback. From the signalling potentiometer slide current is sent to the АРУ-2 position indicator.

The manual control switch is employed to actuate the servo rod when the servomechanism is not operated from the control unit.

Electric Circuit (Fig.11)

Element	Purpose
МРД-106 potentiometer transmitter	Converts impact pressure to proportionate D.C. voltage

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Element	Purpose
МРД-12Б potentiometer transmitter	Converts absolute barometric pressure (flight altitude) to proportionate D.C. voltage
ПЭВ-25Х-510 ohm resistor	Is out in as a voltage divider to supply reduced voltage to the potentiometers of the МРД transmitters and the feedback potentiometer
АВС-18-53 selenium rectifier	Cuts off the circuit of the altitude bridge diagonal (windings 1-4 of the РПС polarized relay)
РПС polarized relay	Sums up signals coming from the МРД transmitters and feedback
РС-3 relays	Serve as auxiliary power amplifiers between РПС and РРТ-40 relays
РРТ-40 relay	Serves as a power amplifier. Engages the servomechanism electric motor and effects its electric and mechanic braking
МУ-130АП electric motor	Shifts the servomechanism rod
КВ-6 microswitches	Interrupt the supply circuits of the РРТ-40 relay windings, with the servo rod at the extreme positions, and give indication of the servomechanism BIGGER ARM.
R_2 ВС-0.5, 590-620-ohm resistor	Limits the current value in windings 1-4 (altitude bridge) of the polarized relay
R_1 ВС-0.5, 200-300-ohm resistor	Adjusts the beginning and the end of the automatic system altitude operation

Element	Purpose
R_3, R_5, R_6 ВС-0.5-5,1-18-kilohm resistors	Are positive feedback circuit resistors. Employed to reliably close the contacts of the РПС polarized relay, reduce the hysterisis and assymetry in the automatic system operation for the number of the servo rod movements
Feedback potentiometer	Ensures negative feedback by the position between the sensitive elements and the servo rod
R_4 ВС-0.5, 100-ohm resistor; КМБГ 2х0.5 mfd, 160-V capacitor	Are fitted in the quench circuit to extinguish spark across the contacts of the РПС relays, improve reliability and prolong their service life
АРУ-2 position indicator	Serves to indicate the position of the servomechanism rod relative to the speed and altitude of flight

Circuit Operation

Let us now examine the functioning of the automatic system servo as shown in Fig. 12. The ПРД-10С (impact pressure), ПРД-12С (flight altitude) and feedback potentiometers are arranged on the principle of a double bridge with the windings of the РПС polarized relay cut into its diagonals.

The bridge uses 3 - 11 V taken from the voltage divider (ПЭВ-25Х-510 - ohm resistor).

The double bridge circuit incorporates the following two components:

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

I - impact pressure transmitter (МРД-106) and feedback potentiometers. Winding 5-6 of the РПС polarized relay is cut into the bridge diagonal.

II - potentiometers of the МРД-106 and МРД-126 transmitters. Cut into the bridge diagonal are two series-connected windings (1-2 and 3-4) of the РПС polarized relay, selenium valve С and resistor R_2.

Operation of the First Bridge (Impact Pressure Bridge)

As impact pressure increases the $П_1$ potentiometer slide (See Fig.12) moves along the pointer thereby increasing the difference between the positions of the slides of the МРД-106 transmitters and feedback potentiometers, i.e. the slides are found to be under different potentials.

Winding 5-6 of the РПС relay carries current proportional to the mismatch value and corresponding to it in sign. When the above current reaches a value sufficient for the relay to operate, armature Я and contact Л will close thereby switching on the РС-3 relay whose contacts will feed current to the winding of the РРТ-40 relay; the relay cuts in the electric motor which will shift the servomechanism rod towards SMALLER ARM. Moving together with the rod is the slide of the feedback potentiometer $П_3$ which decreases the mismatch value and, hence, the current in winding 5-6.

When mismatch reaches the value of the dead zone or is below it, i.e. when current running in winding 5-6 equals the relay dropout current or is below it, armature Я of the polarized relay will depart from terminal Л to neutral position, the supply circuit of the РС-3 and РРТ-40 relays winding will be interrupted and the motor will stop. Further increase in impact pressure causes the cycle of operation to repeat.

Thus, the servomechanism rod follows up the mismatch value intermittently in accordance with the changes in impact pressure, by separate engagements as shown in Fig. 13.

As has been noted above (See Fig.5) the automatic system begins to operate for impact pressure not from zero but from impact pressure equal to q_2. This nonlinearity in the system operation is ensured by properly adjusting the terminal switch and the feedback potentiometer position.

When cutting in the circuit represented in Fig. 12, in position I, i.e. when the impact pressure is absent, initial mismatch introduced in the system provides for BIGGER ARM (extension of the rod). Simultaneously, the slide on the МРД-106 transmitter potentiometer is located at the beginning of the winding and on the feedback potentiometer it is displaced from this position towards SMALLER ARM (retraction of the rod). In this case current flows through winding 5-6 of the РПС relay and armature Я and the contacts of the РС-3 relay are closed towards BIGGER ARM but the circuit of the respective winding of the РРТ-40 relay is opened by the terminal switch and no current is fed to the electric motor.

After impact pressure reaches q_2 (See Fig.5), the slide of the МРД-106 transmitter potentiometer moves to position II, the current in the winding of the polarized relay becomes weaker than the dropout current and the armature Я assumes neutral position. Further increase in impact pressure will cause the system to operate as described above (operation within q_2-q_1 will be based on a linear principle). After the impact pressure reaches q_1 the circuit of the РРТ-40 relay winding is opened by the terminal switch of the SMALL ARM (extreme retracted position) and the system will not operate with an increase of impact pressure.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

The arm of the automatic system to the booster remains constant (~ 50 mm).

Operation of the Second Bridge (Altitude Bridge)

The second bridge is intended for introducing altitude correction in the impact pressure operation. At flight altitudes above 5000 m. the automatic unit linearly follows the change in impact pressure to a certain value (for each altitude) setting the servo rod to respective positions; increase of impact pressure above these values is not registered. At altitudes of 10,000 m. and over the system completely ceases to react to the change in the impact pressure and the servomechanism rod assumes a position of [illegible].

The altitude bridge comprises the potentiometers of the [illegible] and [illegible] transmitters which are so connected that in the initial position (at q = 0 and H = 0 - 5000 m.) their slides are across the sides with reverse polarity (see Fig. 10), i.e. terminal A of the МРД-10Б transmitter potentiometer is connected with terminal Б of the [illegible] transmitter potentiometer and terminal Б, with terminal A.

Cut into the bridge diagonal are two series-connected windings (1-2 and 3-4) (we shall call them winding 1-4) of the РЭС polarized relay, selenium rectifier АВС-13-53 and resistor R_2. In initial position I the mismatch between the potentiometer slides is at its maximum but current does not flow along winding 1-4 since the selenium rectifier adjusted for passing only the current of reverse polarity is cut off and is triggered only at an altitude of over 5000 m. irrespective of the МРД-10Б transmitter slide position.

As the altitude rises above 5000 m. the slide of the МРД-12Б transmitter shifts along the pointer and when the slides are matched (III) the selenium rectifier triggers and winding 1-4 begins to conduct current. In this position the altitude correction is cut in for operation.

Winding 1-4 is so connected that the current flowing along it induces a magnetic flux directed opposite to the magnetic flux of winding 5-6 as impact pressure increases.

When the automatic system operates from impact pressure the feedback potentiometer slide follows the position of the МРД-10Б transmitter slide.

When the slide of the МРД-10Б transmitter assumes position III (in the direction indicated by the pointer) current in windings 1-4 and 5-6 induces magnetic fluxes equal in value (equality is obtained by selecting proper resistor R_2 when adjusting the system) and opposite in direction. The total magnetic flux is zero or below the relay pickup current. Further movement of the slide of the МРД-10Б transmitter potentiometer, as the speed rises, causes a proportionate increase of the current in windings 5-6 and 1-4 and, hence, their magnetic fluxes remain equal and opposite in voltage and the armature Я remains in neutral position.

Thus, despite the shift of the МРД-10Б transmitter slide to position III and further in the direction of the pointer the system does not react to this movement and the servomechanism rod remains fixed in position II.

As the flight altitude increases the slide of the МРД-12Б transmitter moves along the pointer and at a constant impact pressure (position of the МРД-10Б transmitter slide is constant) current in the altitude bridge diagonal (winding 1-4) increases whereas in the speed diagonal it retains the same value. The intensity of the magnetic flux of winding 1-4 exceeds that of winding 5-6,

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

armature Я and contact II close, the relays PC-3 and PAT-40 operate and the electric motor shifts the servo rod towards BIGGER ARM until the magnetic fluxes in the windings become equal.

The servomechanism rod assumes a position corresponding to the new flight altitude. At 10,000 m. and over the servo rod assumes a position of BIGGER ARM at any impact pressure value.

Positive Feedback Circuit

The positive feedback circuit reliably closes the contacts of the polarized relay, reduces the current hysteresis and lessens the asymmetry of the automatic system performance for the number of operations required for extension and retraction of the servomechanism rod due to possible difference of current values of the PHC polarized relay operation towards Я and II.

Hysteresis is the difference in the position of the automatic system servo rod when it is pushed or pulled at the same speed and altitude.

The positive feedback circuit comprises the polarized relay winding 11-12 and three resistors ЗС-0.5 R_5, R_3, R_6 (Fig.14).

When armature Я of the polarized relay and contact II close, winding 11-12 of the PHC carries current which induces a magnetic flux coinciding in direction with the total control magnetic flux, which has brought contacts Я and II together, and is summed up with it to increase the contact pressure of Я and II.

The values of resistors R_5 and R_3 are so selected as to approximate the current flowing through winding 11-12 to the relay dropout current. In this way, as the motor operates for misalignment, the PHC contacts open when the

total magnetic flux $\Phi_{\text{dropout 2}}$ of the control windings is near zero and not at $\Phi_{\text{dropout 1}}$, as would be the case with deenergized winding 11-12; in this instance, the servomechanism rod moves somewhat further (Fig.15).

With an opposite sign for closing contacts Я and I unbalanced the total magnetic flux in the control windings should change not by

$$\Phi_{\text{total 1}} = \Phi_{\text{dropout r}} + \Phi_{\text{pickup 1}}$$

but by

$$\Phi_{\text{total 2}} = \Phi_{\text{dropout r with feedback}} + \Phi_{\text{pickup 1}}$$

(See Fig. 15). This reduces the difference in the position of the extended or retracted servo rod at the same speed and altitude of flight.

Resistor R_6 is employed to eliminate asymmetry in the system work for the number of operations required for extending or retracting the servomechanism rod. Depending on the asymmetry of the PHC relay for the pickup current towards I and II, resistor R_6 is soldered during adjustment either to terminal 11 or 12 of the PHC relay. Then, as armature Я and contacts I and II close, different resistors are connected in series with winding 11-12 and the windings pass heavier or weaker current, respectively.

As has been noted above, the value of this current determines the amount of mismatch followed up by the servomechanism rod and, hence, the number of operations required for the entire rod travel.

The asymmetry in the system operation is eliminated by selecting proper resistor R_6 and proper jointing.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Dynamic Braking

Electrodynamic braking is intended to retain the servo-mechanism rod in a definite position and preclude self-oscillations (oscillating motion of the servo rod at the state of correspondence) arising due to the inertial runout of the electric motor. Like the electric motor reversing, the braking is effected by means of a PPT-40 reversing and braking relay which short-circuits the winding of the armature and the deenergized field winding. In this instance, the motor operates as a short-circuited generator and stops instantaneously.

Current fed to the motor interrupts the braking circuit.

Position Indicator

The position indicator is a voltmeter with a measurement range of 0-30 V whose scale is graduated in units of speed and flight altitude.

Current is fed to the position indicator from the sliding potentiometer whose slide is on the same carrying axle that of the feedback potentiometer and shifts proportionally to the movement of the servo rod. The potentiometer is powered from the aircraft mains.

DESIGN OF THE APU-2A CONTROL UNIT AND ITS COMPONENTS

As to its design, the control unit is a system of independent components incorporated in a common electric circuit and mounted on the same panel.

The design of the control unit is shown in Fig.16.

The APU-2A control unit comprises the following main parts:

small-size potentiometer transmitter ПТД-106 (Ref. No. 49 and Fig. 23);

small-size potentiometer transmitter МРД-126 (Ref. No.53 and Fig. 28);

РПС polarized relay (Ref. No. 43 and Fig. 32);

РПС polarized relay block (11);

РС-3 power relays (Ref. No. 7 and Fig.35);

РРТ-40 reversing and braking relay (Ref.No. 27 and Fig. 40);

panel (Ref. No. 21 and Fig. 17);

bracket (Ref. No. 20 and Fig. 18);

base (Ref No. 16 and Fig. 19);

cover 13;

plug connector РР32ПК123Г1(31);

terminal block (Ref.No. 40 and Fig. 20);

panel (Ref. No. 2 and Fig 21) with type ВС-0,5 resistors (12);

adjustable resistor ПЭВ-25Х-510 ohms (3);

selenium rectifier АВС-18-53 (8);

capacitor КБГЧ-3-160-2х0.5 (10);

plate (Ref. No. 17 and Fig. 22) with dampers 273049-1-2 (44).

Panel

The panel (Ref. No. 21 and Fig.17) made from aluminium alloy is a flat rectangle with four legs ending in lugs with fastening holes.

The panel supports a stand with four round holes to fasten the РРТ-40 reversing and braking relay and one large oval hole provided to lessen the weight of the assembly.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

PPT-40 relay 27 is attached to the stand of panel 21 by screws 26 with spring washers placed under the screw heads. From the other side of the stand, panel 21 supports PHC polarized relay 43 which is fastened in the following way.

Glued to the panel with one of its faces is washer 42 stamped from sponge rubber. The other face of the washer carries an aluminium washer. PHC polarized relay 43, butt-jointed with the PHC polirized relay block 11, is fitted onto the aluminium washer resting on a fillet provided in the block. Bracket 20 fitted onto the polarized relay is attached through its lugs to the panel by screws 22. Sponge rubber is inserted into the joint between the bracket and the relay. Thus, the polarized relay is not rigidly-secured: it can slightly shift along the vertical axis under the action of external forces due to rubber washer 42 and a rubber gasket provided in bracket 20. The shift of the PHC relay is governed by the compression of rubber washer 42. Washer 42 is compressed by 0.5 - 0.8 mm of its original thickness by placing washers under the lugs of holder 20.

The conductors from the PHC polarized relay terminals are passed through a hole provided in panel 21.

Attached to the bottom of panel 21 are: two PC-3 relays 7 with screws 6, AEC-18-53 selenium rectifier 8, MBTH -3-160-2x0.5 capacitor 10 with screws 9, panel 2 with BC-0.5 resistors 12 with screws 1 and ПЭВ-25Х-510-ohm adjustable resistor 3 with screws 5. To prevent the shift and play of the adjustable resistor it is mounted on textolite bushings 4.

The bunched conductor leading to the PPT-40 reversing and braking relay at the side of the panel is encased in vinyl chloride sleeve 23 and is secured by clamp 24 attached to the panel by screw 25.

Panel 21 is fitted with its legs on base 16 and is attached to it by screws 28.

Bracket

The bracket (Ref. No. 20 and Fig. 18) serves to secure the PHC polarized relay. It consists of cap 3 stamped from aluminium sheet with a cut-out bottom. Two lugs 1 are attached to the cap external sides by rivets 4. The bracket is secured in position through the holes drilled in the lugs. Gasket 2 made from sponge rubber is glued to the cap inner surface.

Base

The base (Ref. No. 16 and Fig. 19) is cast from aluminium alloy. Terminal block 40 is fitted into a special recess provided in the base where the conductors are passed into the APY-2A control unit. The terminal block is pressed against the base by shaped nut 41. Panel 21 is mounted and fastened on four shoulders provided with blind threaded holes. Cover 13 is fitted onto a milled circular groove with glued-in packing ring 1. Misalignment of cover 13 in the base is prevented by two lock pins 3 which fix it in the required position. The small-size resistive transmitters МРД-106(49) and МРД-126(53) are secured with screws 37 in two recesses provided for the purpose. Washers 36 placed under the two lugs of the МРД-126 transmitter keep it in a vertical position. The transmitters are protected by cover 30 fastened to the base by screws 52.

Attached to the external side of the cover is the manufacturer's nameplate. The cover has a hole for the resistive transmitter union. The cover is secured by three clamps riveted to its internal sides.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

The bunched conductor running from the APY-2A control unit via terminal block 40 is encased in shielding armoured braid 35 and terminates in plug connector 31. The soldered joints are protected with vinyl chloride sleeves and covered with cap 38 secured to the base by screw 47. The end of the shielding braid (at the base) passes under cap 38 and together with the bunched conductor is pressed to the base by clamp 55 with screws 54. The other end of the braid is connected with the plug connector via union 32, collar 34 and screw 33.

Panel 21 with all the assemblies mounted on it is fitted onto the base and is closed with cover 13. The base side opposite to cover 13 supports four bosses securing plate 17 with dampers 44 by means of screws 45.

Cover

Cover 13 cast from aluminium alloy is a rectangular casing with a flange. Its internal sides have grooves milled opposite adjustable resistor 3, resistors 12 and PMC polarized relay 43 to bring away the current-carrying parts from metal surfaces and preclude contact between the PMC polarized relay and the cover side.

The cover is attached to base 16 by a flange with eight screws 14 and five screws 19 with nuts 29 and 46.

Rubber packing rings 15 and 39 placed between the cover and the base and between the base and the terminal block ensure proper sealing inside the control unit.

The assembled control unit is locked with wire 51 and seal 50.

The internal layout of the control unit is done according to a wiring diagram (Fig.23) with coloured wires, grade MTTB, 0.5 and 1.5 mm^2 in cross-section; the plug connector pegs and the block terminals are connected according to the diagram with grade MTBI wire, 0.5 and

and 1.5 mm^2 in cross-section. The wires are joined with solder POC-40 and protected with vinyl chloride sleeves.

Plug Connector

The RP32PK123T1 plug connector links the circuit wiring and the APY-2A control unit.

The plug connector is a metal body comprising a receptacle and plug with pins and sockets secured in insulators and with terminal nuts for fastening the conductors.

Terminal Block

The terminal block (Ref. No. 40 and Fig. 20) connects the external circuit with the internal wiring of the APY-2A control unit where it passes through base 16.

The terminal block consists of body 1 which is a textolite disc with bevelled fillets and seventeen brass terminals 2 glue-pressed into the disc.

The wires are soldered to the sockets provided in the terminal end-faces, in conformity with the diagram. The figures marked on both sides of the body denote the ordinal number of each terminal. The notches forming the figures are filled with white enamel.

Panel

The panel (Ref. No. 2 and Fig. 21) consists of two textolite plates 1 and 2 glued together. Attached to plate 2 with rivets 4 are six pairs of terminals 3 located opposite one another. Each terminal is provided with a hole for soldering the conductors in conformity with the diagram. Resistors 12 are soldered on top of the terminals.

The panel is fastened through two holes provided for the purpose.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Resistors

For adjusting the control unit with the servomechanism use is made of type BC-0.5 constant carbon resistors 12 whose ratings are within the following limits:

R_1 - from 200 to 300 ohms;

R_2 - from 390 to 620 ohms;

$R_3 = R_5 = R_6$ from 5.1 to 18 kilohms; R_4 = 100 ohms.

The indicated values compensate for the deviations in the parameters of ready-made articles fitted into the APY-2A control unit from the nominal ratings if these parameters are within the tolerance margin provided by the technical requirements for these articles.

Adjustable Resistor

Type [illegible]-5X-5IO -ohm adjustable resistor 3 functions in the circuit as a bleeder supplying reduced voltage to the potentiometers of the small-size resistive transmitters MPT-I06 and MPT-I26 and the feedback potentiometer.

It is made from high-resistance wire wound around a ceramic tube and protected with a layer of vitreous enamel. The contact between the current collector and the resistance wire is effected through a "window" without enamel coating.

Selenium Rectifier

Type ABC-13-53 selenium rectifier 8 is made of selenium rectifying elements on an aluminium base. The selenium rectifier cuts off the circuit of the altitude bridge diagonal (windings 1-4 of the PIK polarized relay).

Capacitor

Type MBTH -3-160-2x0.5 capacitor 10 together with the BC-0.5, 100-ohm resistor is incorporated into the quench circuit to extinguish spark arising across the contacts of the PIK polarized relay.

The MBTH -3-160-2x0.5 metallized-paper airtight capacitor is fitted into a rectangular metal casing with a fibreglass or ceramic insulator.

Plate with Dampers

Plate (Ref.No. 17 and Fig.22) with dampers 3 serves as a resilient medium for the APY-2A control unit and for securing it in the aircraft.

Plate 1 is stamped from heat-treated duralumin sheet, 2 mm thick. Four type 273C49-1-2 dampers 3 are attached to the plate with screws 4 and nuts 2. Washer 5 is placed between the screw head and the damper end-face. To prevent nut 2 from unscrewing, it rests on spring washer 6.

ARRANGEMENT, PRINCIPLE OF OPERATION AND DESIGN OF INDIVIDUAL ELEMENTS OF THE APY-2A CONTROL UNIT

The APY-2A control unit supports the following ready-made articles:

small-size potentiometer transmitter MPT-I06;
small-size potentiometer transmitter MPT-I26;
PIK polarized relay;
PC-3 relay;
PPT-40 reversing and braking relay;

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

The wiring diagram of the control unit is represented in Fig. 23. The layout of the parts in the APУ-2A control unit is shown in Fig. 24.

Type МРД-106 and МРД-126 Small-Size Potentiometer Transmitters

Purpose

The МРД-106 and МРД-126 transmitters vary their resistance in proportion to the measured air pressure taken from the aircraft airspeed tube.

The МРД-106 transmitter is a manometer-type instrument changing the resistance of the built-in potentiometer due to an increase or decrease in pressure head, i.e. due to the speed of the aircraft flight within the preset range.

The МРД-126 transmitter is an aneroid-type instrument changing the resistance of the built-in potentiometer depending on an increase or decrease in the aircraft flight altitude within the preset range.

The external view of the transmitters is shown in Fig. 25.

Specifications

МРД-106 Transmitter

Supply voltage	maximum 15 V
Potentiometer resistance	1000±200 ohms

Resistance produced by the transmitter at normal temperature and the pressure variation from the minimum to maximum value changes	minimum 92%
Transmitter is intended to vary its resistance in proportion to the surplus pressure	from 0 to 6000 kg/m^2
Checked pressure values	0; 600; 1200; 2400; 3600; 4800; 5400 and 6000 kg/m^2
Overload pressure value	7200 kg/m^2
Pressure value when checking for airtightness	10 mm Hg, abs.
Weight	maximum 0.3 kg

МРД-126 Transmitter

Supply voltage	maximum 15 V
Potentiometer resistance	1000±200 ohms
Value of produced relative resistance:	
at zero pressure	minimum 0.3%
at maximum pressure	maximum 99.7%
Transmitter varies its resistance in proportion to the absolute pressure	from 450 to 200 mm Hg, abs.
Checked pressure values	450; 425; 400; 375; 350; 325; 300; 275; 250; 225; 200 mm Hg, abs.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Overload pressure value	10 mm Hg, abs.
Pressure value when checking for airtightness	10 mm Hg, abs.
Weight	maximum 0.3 kg

Design and Principle of Operation

The principle of the transmitter operation is based on the functional dependence between the measured pressure and the elastic strain of the sensitive element.

The key diagram of the transmitter is represented in Fig. 26.

Sensitive element 1 (Fig. 26) responding to the measured pressure deforms and converts the measured pressure into a linear shift of the brush-holder with brushes 2. As the pressure rises, sensitive element 1 deflects and via transfer-multiplier mechanism 3 moves brush-holder 2 with brushes along the coils of potentiometer 4. A reverse action during pressure drop is ensured by return spring 5.

In the MP-10s transmitter static pressure is fed into the housing and dynamic pressure into the internal cavity of the sensitive element. In the MP-126 transmitter absolute pressure is fed into the housing.

The electric circuit of the transmitter is shown in Fig. 27.

Design

The transmitter comprises the following main parts:
sensitive element;
transfer-multiplier mechanism;
base;
housing.
The transmitter design is shown in Fig. 28.

Sensitive Element

The transmitter sensitive element is manometric cell 5 made up of two resilient corrugated diaphragms welded together. To the lower diaphragm of the cell is welded bottom centre 4 secured on plate 24 by one nut 3 with a washer. Welded to the upper diaphragm of the cell is upper centre 6 with rod 7 attached by a lockpin. The other end of rod 7 is secured on axle 42 with a pin.

Transfer-Multiplier Mechanism

The transfer-multiplier mechanism is mounted on plate 24 designed as a platform with two stands and one bracket. The two stands support axle 42. Manometric cell 5 is secured in the plate bottom. Rod 7 leading to axle 42 is passed through a hole provided in the plate centre.

Axle 42 is fastened in the plate stands by stop-punched screw 41 and adjusting screw 50. Screws 50 and 41 are held in place by two screws 51. Axle 42 supports brush-holder 57 with brushes, fork 45, insulating bushing 43, pins 46 and 48. Brush-holder 57 is secured with screw 54 and fork 45 with screw 52. Pin 46 carries adjusting nuts 47.

The bracket supports potentiometer 21 with base 20 attached by adjusting screw 19. A washer and lock washer 53 are placed under adjusting screw 19. The bracket of plate 24 is provided with flat spring 13 taking up play in the potentiometer unit.

Stop 18 fitted in the potentiometer base limits the travel of brush 56 along potentiometer 21.

Return spring 9 secured in pin 48 and clamp 8 serves to bring brush 56 to initial position.

Clamp 8 is fastened by screw 49 with a washer on plate 24. Screw 12 designed to protect the manometric cell

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

from being destroyed by overload pressure is fitted into plate 55 secured by screw 58 with a washer. Locknut 11 is turned onto screw 12.

Current is fed to the brushes via current-carrying spring 10 mounted on brush-holder 57 and an insulating gasket.

The insulating gasket is attached to plate 24 by screw 44.

Plate 24 is jointed to base 26 by strip 23 and two screws 22.

Current-carrying spring 10 and the output leads of potentiometer 1 are linked with the terminals of plug 38 by [illegible] in a vinyl chloride insulation.

Base

Base 26 is provided with two holes. One hole accommodates [illegible] secured with two nuts 28. The union sealing is ensured by rubber washers. Pipe conduit 29 is fitted into the hole inside the union. The other end of the pipe conduit is secured in bottom centre 4.

To protect the internal cavity of the sensitive element from shocks, provision is made for mesh 31 fastened by ring 32 in union 30.

Plug 38 is fitted into the other hole of base 26 and secured therein by two screws 40. Bushing 37 is screwed onto the plug. Shielding braid 34 is held in place by strap 35 secured on bushing 37 with two screws 36. Screws 36 rest on slot washers. Sealing between the plug and the base is ensured by a rubber washer.

The base is provided with a special groove with a fitted-in rubber gasket ensuring sealing when housing 17 is being screwed on.

Three bosses with holes provided on the base serve for fastening the transmitter.

Housing

The housing of transmitter 17 is shaped as a cylinder. The housing of the МРД-106 transmitter supports a union for feeding static pressure while the МРД-126 transmitter has no such union.

The housing is threaded inside to screw onto base 26.

The МРД-126 aneroid-type transmitter differs from the МРД-106 manometer-type transmitter by:

(a) a different sensitive element (aneroid cell instead of manometric cell);

(b) absence of static union 15;

(c) absence of pipe conduit 29.

PHC Polarized Relay

Purpose

The PHC polarized relay is an electromagnetic three-position relay of high sensitivity. It is designed to supply an impulse to switch on the PC-3 relay.

The external view of the PHC relay is shown in Fig. 29 and its key circuit in Fig. 30.

Main Technical Characteristics

Sensitivity (operating ampere-turns) of the relay in normal conditions at 20±5°C is within	0.85 to 1.65 ampere-turns
Current in the contact circuit	maximum 0.2 A
Weight	maximum 0.25 kg

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Winding Data

Number of coils	2
Number of turns in each coil	5
Type of winding	layer

No. of winding	Grade of wire	Wire material	Diameter of bare wire, mm	Diameter of insulated wire, mm	Number of turns	Resistance at +20°C in ohm
1	MGM	Copper	0.1	0.115	2200	100±10%
2	MGM	Same	0.09	0.1	2200	124±10%
3	MGM	Same	0.07	0.08	7500	1000±10%
4	MGM	Same	0.14	0.155	50	1.5±10%
5	MGM	Same	0.05	0.065	300	80±10%

Design and Principle of Operation

The PHC relay is a cut-in relay with permanent magnets. It consists of an upper base with a contact group and a bottom base with a magnetic circuit of two different magnetic fluxes - polarizing and controlling. The PHC relay possesses three sources of magnetomotive force (m.m.f.) which induce three fluxes in the magnetic circuit: two polarizing fluxes Φ_p created by the permanent magnets and one controlling magnetic flux Φ_c created by the current flowing in the relay coil.

The polarizing fluxes Φ_p flow from the north poles of the permanent magnets along the shoes through the air gaps to the armature branching off into two parts. Part

of the flux enters the armature in a perpendicular direction to its plane and the other part is branched off into the armature end-face to obtain a definite dependence of the angle of the armature turn on the value of the electromagnetic moment acting on the armature. From the armature the polarizing fluxes are fed, via the operating gaps, into the core end-faces and, through brass bushes and the bottom base, to the south poles of the permanent magnets.

The controlling flux Φ_c flows along the coil cores via jumpers and air gaps which are adjusted by moving the core towards the armature (turning in) or away from the armature (turning out).

The analogous poles of the permanent magnets are connected by the upper and lower bases. This facilitates a symmetrical distribution of the polarizing magnetic fluxes Φ_p.

The magnetic circuit of the PHC relay is shown in Fig. 31.

When the flux flows in the direction shown in Fig. 31 the controlling and polarizing fluxes in the left operating gap are directed opposite each other and should be subtracted, while in the right operating gap they should be summed up since they flow in the same direction. These total fluxes induce in the operating gaps two electromagnetic moments applied to the armature and directed oppositely.

The value of the moments is proportional to the squares of these fluxes.

Thus, the armature is subjected to the effect of a differential moment whose value depends on the polarizing and controlling fluxes and, hence, on the number of ampere-turns of the electric magnet. This electromagnetic moment turns the armature overcoming the spring tension which will depend linearly on the angle of turn until the moment created

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

by the suspension springs becomes equal to the electromagnetic moment. Hence, the angle by which the armature turns is proportional to the ampere-turns of the relay electromagnet.

As the armature turns to a certain angle the moving contact on the armature and the fixed contact close.

A further increase in the ampere-turns results in a rise of contact pressure.

The minimum number of ampere-turns at which the moving and fixed contacts are brought together is called the relay sensitivity.

When the electromagnet coils are deenergized the relay armature is held in the neutral (mean) position by spiral springs. As current is fed to the electromagnet winding, the magnetic flux induced by the electromagnet coil, will overcome the tension of the armature springs and turn the armature to a certain angle thus closing the contacts. When the current flowing in the electromagnet winding is reversed the armature turns to the other side.

Design

The entire assembly is built up on two permanent magnets ensuring the required rigidity and making for a stable operation of the relay.

The relay has practically no body.

The high vibration-proof capacity of the relay is attained through a better structural rigidity, utilisation of double symmetrical armature design which is balanced relative to the axis of rotation, through a lesser weight and moment of inertia.

The relay consists of the following main structural parts:

(a) upper base with a contact group;
(b) permanent magnets;
(c) bottom base with winding coils.

The relay design is represented in Fig. 32.

Upper Base with Contact Group

Upper base 1 is a part of the magnetic circuit of the polarizing magnetic flux. Shoes 2 pressed into the plate of the upper base have through holes supporting contact screws 3. Contact screws 3 are secured on base 1 and are separated from the base and shoes with special insulating bushings.

The armature with a contact segment is fitted between shoes 2 on special bracket 4 which is secured on base 1 with one screw. The bracket is held in place by two pins fastened on base 1 and passed through two holes provided in the bracket. The armature with the contact segment is fastened to bracket 4 by a spring maintaining the armature in the neutral (mean) position.

When the relay winding carries current the armature turns by a definite angle, closes the contacts and twists the armature spring. When the winding is deenergized the spring returns the armature to the mean position.

Prior to assembling the relay adjust proper gaps between the contacts by turning contact screws 3 in or out.

Permanent Magnets

The relay supports two shaped permanent magnets 11 fitted between upper 1 and bottom 5 bases. They are fastened during assembly by screws 12 securing the upper and bottom bases.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Bottom Base with Winding Coils

Bottom base 5 is manufactured from low-carbon steel and is coated with phosphate possessing electric insulation properties which lessen eddy currents and reduce the relay operating time. The cuts provided in the bottom base and in the non-magnetic bushings also make for the lessening of the relay operating time.

The bottom base is provided with two holes with soldered-in non-magnetic bushings 6 ensuring ballast gaps in the relay magnetic circuit and separating the controlling and polarizing fluxes. The thread cut in non-magnetic bushings 6 serves to screw in the cores 7. Screws 8 prevent cores 7 from unscrewing out of base 5.

Fitted onto cores 7 are coils with windings 9. To ensure a closed magnetic circuit the cores are interlinked by armatures 10.

Two shaped permanent magnets 11 are fitted between upper 1 and bottom 5 bases which are linked with four screws 12 thus forming a rigid structure.

Bottom base 5 is secured on prop 13 made from aluminium alloy with two screws 14.

The bottom base is separated from the prop by thin textolite gasket 15 and two textolite bushings 16.

Plastic knife block 17 with sixteen pins is attached to the bottom of prop 13 with four screws (two of them are guide pins 21). Soldered to the block are the leads of the relay windings and the contact system.

The relay is sealed by packing ring 18 made of sulphur-free rubber (elastomer) which is fitted between block 17 and prop 13. The relay is enclosed in cylindrical casing 19 made of soft iron which also serves as a screen protecting the relay against external magnetic fields.

Casing 19 is fastened to prop 13 with two screws 20.

Guide pins 21 serve to fix relay correctly in the connector block where special holes are provided for the purpose.

PC-3 Relay

Purpose

The type PC-3 electromagnetic cut-in D.C. relay is employed as an auxiliary relay actuating the main PIT-40 relay.

The external view of the PC-3 relay is shown in Fig. 33.

Specifications

Main Technical Parameters

Rated voltage of control winding	26 V
Pick-up current at 20±5°C	maximum 90 mA
Dropout current	minimum 25 mA
Weight	maximum 0.053 kg

Winding Data

Wire diameter	0.13 mm
Wire grade	PEM
Material	copper
Type of winding	layer
Number of turns	2500
Resistance at +20°C	130.5 - 159.5 ohms
Output wire cross-section	0.14 mm^2
Grade of output wire	MGTF
Length of unskinned leads	50 mm

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Gaps and Pressures

Contact pressure:	
on normally closed contacts	40 - 60 gr
on normally open contacts at 23 V across the winding	minimum 70 gr
Contact gap	0.92 - 1.08 mm
Magnetic gap	0.8 - 0.9 mm
Pressure travel	minimum 0.15 mm

Design and Principle of Operation

The RP-3 relay is a cut-in clapper-type electromagnetic relay with a V-shaped magnetic circuit comprising a controlling coil connected to the distribution circuit, and a contact group connected to the servo circuit of the relay.

The relay distribution circuit consists of two elements:

(1) receiver-converter, i.e the relay winding designed to pick up and convert an impulse;

(2) control circuit responding to the operating moment created by the electromagnet winding and the opposite moment created by the spring and the armature weight.

The main control process of the relay is called pickup. The reverse process caused by the action of the return spring is known as release or dropout.

Let us consider the relay operation.

Current fed to the relay winding causes it to induce a magnetic flux which interacts with the relay armature and attracts it to the core.

As the armature is attracted to the core it expands the spring with the rest. When the winding is deenergised the spring with the rest returns the armature to its initial position.

The relay contact system consists of one moving and two fixed contacts. The moving contact is secured on the electromagnet armature and shifts together with it.

The armature is a beam which can turn to a certain angle on the relay frame.

The moving contact is fitted on a resilient contact segment and is connected with the output bus-bar via a flexible wire.

The contact segment is secured on the armature and is separated from it by an insulating bushing and gaskets.

The resilient contact segment provided in the relay markedly improves the performance of the contacts especially during vibration

A special clamp keeps the armature reliably secured on the relay frame. The fixed contacts are secured on the relay frame and end in output bus-bars.

The armature is constantly subjected to the action of either the return spring when the relay winding is deenergized or the return spring and the electromagnetic force when the relay winding passes current.

With the winding deenergized, the armature free end and the moving contact segment occupy the extreme upper position, the contact of the moving segment being closed with the upper fixed contact. When the value of current fed to the relay winding is sufficient to make it operate, the armature with the moving segment assumes the extreme botton position and the contact of the moving segment closes with the bottom fixed contact.

The relay operates when the force created by the electromagnet exceeds the tension of the return spring.

To provide for a more reliable contact and create a definite (minimum) contact resistance the contacts should press against each other with a definite force.

If contact pressure is insufficient the operation of the assembly will be unsatisfactory: when switched on,

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

there may be no electric contact, the resistance may increase with a resultant excessive rise of the temperature of the contacts, which will burn and rapidly deteriorate

Besides, at low contact pressure contact may be easily broken even by minor accumulation of dust between the contacts or due to inevitable oxydation.

To ensure the required contact pressure after closing, provision is made for additional deflection of the moving contact spring (pressure travel) which takes place after the contacts are brought together and the armature can still move towards the electromagnet core.

The armature stops after it touches the core. The pressure travel, in addition to creating the required contact pressure, permits the moving contact to slide somewhat in the direction of its motion along the fixed contact. This provides for uniform carbonization and self-cleaning of the contacts of dust, dirt and tarnish.

The key circuit of the PC-3 relay is shown in Fig. 34.

Design

The relay comprises the following main parts:
base with a coil;
armature assembly;
strap and fixed contact bus-bars;
return spring.
The design of the PC-3 relay is shown in Fig. 35.

Base with Coil

The base with the coil consists of the following main parts (Figs 35 and 36): base 3, core 7 and coil 5. The magnetic circuit is created in the relay by base 3, core 7 and armature 8.

The base is a V-shaped stamped part made of grade 3A low-carbon steel. This steel has practically no residual magnetism. The base bottom is provided with two threaded attachment holes. Core 7 is secured in the hole drilled in the centre.

One end of the core is provided with a threaded hole for screw 2 of return spring 4; the other side of the base is provided with two threaded holes for screws 15.

A special groove in the base fastens clamp 6 preventing armature 8 from slipping.

The former of coil 5 is made of compacted powder and is secured to core 7 with glue BF-4.

The coil carries 2500 turns of grade PEM wire, 0.13 mm in diameter. From the outside, the coil is insulated with one layer of impregnated paper K-12, 0.1 mm thick, and one layer of varnished cambric MM-I, 0.1 mm thick. Leads made from MGVB 0.14 mm^2 wire are soldered to the winding input and output. The soldered joints are insulated with varnished cambric MM-I, 0.1 mm thick.

The leads are soldered to the lugs of output bus-bars 17.

The coil and the core are impregnated with varnish 447 and dried.

Core 7 is spun over in base 3.

Armature Assembly

The armature assembly comprises the following main parts (Fig. 37): armature 7, gasket 5 and contact spring 8.

The armature is a Г-shaped stamped part made of 3A steel. One side of the armature is provided with a hole with flattened rest 6 made of brass preventing the armature from sticking due to residual magnetism after the relay winding has been deenergized.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

On the other side the armature has two holes accommodating screws 10 securing contact spring 8 and a bead for supporting the return spring. Screws 10 are insulated from the contact spring with the help of bushings 1 and textolite gaskets 5 and 9.

Both sides of the contact spring carry contact points made of silver-copper alloy. The contact spring is insulated from the armature by a textolite gasket.

The contact spring is connected with output bus-bar 17 via lug 2 and flexible lead 23 (See Fig.35).

Strap and Fixed Contact Bus-Bars

Strap 14 (See Fig. 35) serves for rigid attachment of fixed contact bus-bars 10 and 11 and output bus-bars 17 to the base of relay 3 by screws 15. The fixed contact bus-bars 10 and 11 are separated by textolite gasket 12. Output busbars 17 are separated from each other and from the base by textolite gaskets 18. Flexible leads 21 and 23 from the relay winding and the moving contact spring are soldered to the output bus-bars.

Screws 15 are isolated from the fixed contact busbars and output bus-bars with insulating bushings 16.

Return Spring

Return spring 4 (See Fig. 35) made of grade 65Г steel is provided with a hole through which it is secured on base 3 with screw 2. The spring end supports a rest which, in an assembled relay, presses against the cuts in armature 8.

PPT-40 Reversing and Braking Relay

Purpose

The PPT-40 reversing and braking relay mounted in the APV-2A control unit is intended for remote starting, reversing and electrodynamic braking of the type MV-100AII series-wound D.C. electric motor which shifts the servo rod of the APV-2A electric mechanism via a reduction gear.

The external view of the PPT-40 relay is shown in Fig. 38.

Specifications

Main Characteristics

Supply voltage	27 V
Operating voltage range	from 24 to 30 V
Current in the circuit of main contacts	40 A
Current in the circuit of auxiliary contacts	10 A
PT-40 relay pickup voltage:	
(a) with the relay cold at ambient temperature of 20±5°C	maximum 16 V
(b) with the relay hot at ambient temperature of 50°C	maximum 20 V
Yoke travel from the moment the contacts close to the end of the armature travel corresponding to the relay pickup and return of the mechanical gear to initial position on switching off the relay	minimum 0.5 m

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Voltage drop across the relay contacts at rated current value, for one pair of contacts	maximum 120 mV
Stable overheat temperature of the contacts	maximum 100°C
Relay operating duty	continuous
Relay weight	maximum 1 kg

Winding Data

Number of coils	2
Wire grade	PEL
Wire diameter	0.21 mm
Number of turns	3600-3800
Resistance at 20°C	110±10 ohms
Grade of coil output wire	MTB
Wire cross-section	0.2 mm^2
Length of unstripped leads	60 mm

Design and Principle of Operation

The PPT-40 unit comprises two type PT-40 relays mounted on a common panel and interlinked by a common electric circuit.

For connection to the mains the panels are provided with external power and switching terminals. The key circuit is shown in Fig.39.

PT-40 Relay

The PT-40 relay is a plunger electromagnet with a closed magnetic circuit comprising two parts:

(a) control electromagnet connected to the control circuit;

(b) contact group connected to the servo circuits of the APY-2A system.

The movable core of the electromagnet communicates via an arm with the moving floating contacts. The fixed contacts are secured on the PT-40 contact panel.

The moving contact group comprises a plastic carriage supporting two power contact strips and one auxiliary strip. Each power contact strip closes two fixed contacts. One pair of contacts is normally closed (18-19) and the other-normally open (16-17). The auxiliary strip closes two normally open contacts (12-13) when the relay operates and two normally closed contacts (14-15) when the relay is deenergized. Terminals 10-11 serve to connect the winding of the PT-40 relay to the control circuit.

The contact strips are secured on a plastic carriage by springs which arrangement greatly improves the performance of the contacts especially during vibration.

The carriage is constantly subjected to the action of either the return spring when the relay winding is deenergized, or the return spring and the electromagnetic pull when the relay winding carries current.

With the winding deenergized, the contact pairs 12-13 and 16-17 are opened. When current fed to the relay winding is sufficient for the relay to operate the carriage assumes an opposite extreme position and contact pairs 12-13 and 16-17 close. Simultaneously, the contact pairs 14-15 and 18-19, which were closed in a deenergized relay, open. As the relay operates, the electromagnet produces a definite pull which overcomes a number of counteracting forces when the carriage shifts.

These counteracting forces are the following:

(a) tension of the return spring which expands as the carriage moves thus accumulating a certain amount of energy necessary to return the carriage to the initial position when the relay winding is deenergized;

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

(b) force created by friction of all moving parts;

(c) contact pressure of the normally open contacts.

This type of relay employs push contacts, a definite contact pressure being the main requirement to ensure a reliable contact and a definite (minimum) contact resistance.

If the contact pressure is insufficient, the system does not respond promptly: on switching on the relay there may be stray or no contact. This increases the contact resistance which will result in a sharp rise in the temperature, excessive sticking accompained by metal transfer and rapid damage of the contact material.

Besides, at low contact pressure contact may be broken even by insignificant accumulation of dust between the contacts or due to inevitable tarnishing.

To ensure the required contact pressure after the closing of the contacts, provision has been made for additional resilient travel of the contact strip known as pressure travel. This travel takes place after the contacts are brought together and the carriage can still move. The motion of the carriage ceases when the contact strip comes to rest against the cut in the carriage.

In addition to contact pressure and pressure travel no less important is the ability of the contacts to break the electric circuit at various combinations of voltage and intensit This voltampere property is determined on the basis of the voltampere characteristic of the arc corresponding to the predetermined maximum contact separation.

The relay electromagnet pull gains in strength as the ampere-turns increase and the air gap becomes smaller. The number of ampere-turns in the PT-40 relay depends on the value of input current and the resistance of the electromagnet winding.

As the relay operates, supply voltage and winding resistance remain constant while the air gap decreases thereby providing for a greater pull. Thus, to operate the relay the winding should be fed with a voltage at which the electromagnet pull exceeds the summed up opposing force. This voltage is called the relay operating or pickup voltage. The voltage at which the relay is cut off, i.e. when the sum of return spring tension, contact pressure and the friction force exceeds the electromagnet pull, is called the relay release or dropout voltage.

The value of the pickup and dropout voltages varies depending on the temperature of the windings (due to the change in their resistance). As the temperature rises the pickup and dropout voltages increase while at a lower temperature they decrease.

PPT-40 Relay

When switch II (See Fig.39) is set in position II, current will flow from the mains plus via terminal 1 of PPT-40 relay, normally closed contacts 14-15 of relay I (PT-40), the electromagnet winding of relay II (PT-40), terminals 10_1-11_1 and terminal 3 of PPT-40 relay to the minus. Simultaneously, the magnetic flux induced in the winding pulls the core of relay II (PT-40) into the sleeve until it touches the fixed pole. The moving core turns a lever which is hinged to the carriage and forces the latter to move in the direction opposite to the core travel. The other side of the carriage is also hinge-jointed to the second lever which turns about its axis and expands the return springs secured on its ends. When the lever connected to the carriage turns, the carriage end-face presses against the adjusting screw of the break-make contact lever. The lever turns around its axis and changes over the break-make contact from terminal 22 to terminal 21 thereby preparing the circuit for subsequent electrodynamic braking of the reversible electric motor after power supply is cut off.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

(b) force created by friction of all moving parts;

(c) contact pressure of the normally open contacts.

This type of relay employs push contacts, a definite contact pressure being the main requirement to ensure a reliable contact and a definite (minimum) contact resistance.

If the contact pressure is insufficient, the system does not respond promptly: on switching on the relay there may be stray or no contact. This increases the contact resistance which will result in a sharp rise in the temperature, excessive sticking accompained by metal transfer and rapid damage of the contact material.

Besides, at low contact pressure contact may be broken even by insignificant accumulation of dust between the contacts or due to inevitable tarnishing.

To ensure the required contact pressure after the closing of the contacts, provision has been made for additional resilient travel of the contact strip known as pressure travel. This travel takes place after the contacts are brought together and the carriage can still move. The motion of the carriage ceases when the contact strip comes to rest against the cut in the carriage.

In addition to contact pressure and pressure travel no less important is the ability of the contacts to break the electric circuit at various combinations of voltage and intensity. This voltampere property is determined on the basis of the voltampere characteristic of the arc corresponding to the predetermined maximum contact separation.

The relay electromagnet pull gains in strength as the ampere-turns increase and the air gap becomes smaller. The number of ampere-turns in the PT-40 relay depends on the value of input current and the resistance of the electromagnet winding.

As the relay operates, supply voltage and winding resistance remain constant while the air gap decreases thereby providing for a greater pull. Thus, to operate the relay the winding should be fed with a voltage at which the electromagnet pull exceeds the summed up opposing force. This voltage is called the relay operating or pickup voltage. The voltage at which the relay is cut off, i.e. when the sum of return spring tension, contact pressure and the friction force exceeds the electromagnet pull, is called the relay release or dropout voltage.

The value of the pickup and dropout voltages varies depending on the temperature of the windings (due to the change in their resistance). As the temperature rises the pickup and dropout voltages increase while at a lower temperature they decrease.

PPT-40 Relay

When switch II (See Fig.39) is set in position II, current will flow from the mains plus via terminal 1 of PPT-40 relay, normally closed contacts 14-15 of relay I (PT-40), the electromagnet winding of relay II (PT-40), terminals 10_1-11_1 and terminal 3 of PPT-40 relay to the minus. Simultaneously, the magnetic flux induced in the winding pulls the core of relay II (PT-40) into the sleeve until it touches the fixed pole. The moving core turns a lever which is hinged to the carriage and forces the latter to move in the direction opposite to the core travel. The other side of the carriage is also hinge-jointed to the second lever which turns about its axis and expands the return springs secured on its ends. When the lever connected to the carriage turns, the carriage end-face presses against the adjusting screw of the break-make contact lever. The lever turns around its axis and changes over the break-make contact from terminal 22 to terminal 21 thereby preparing the circuit for subsequent electrodynamic braking of the reversible electric motor after power supply is cut off.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

After relay II (PT-40) has operated, the motion of the carriage causes normally closed contacts 14_1-15_1, to open thus breaking the circuit of the winding of relay I (PT-40). This precludes simultaneous pickup of both relays (I and II). Normally open contacts 16_1-17_1 close and the current is fed from terminal 7 of PPT-40 relay (plus terminal) via these contacts and terminal 9 of PPT-40 relay to the electric motor right-side winding.

The minus is carried to the electric motor via the armature. The electric motor rotates until the terminal switch of the electric mechanism deenergizes the circuit of the winding of relay II (PT-40). Contacts 18_1-19_1 open and break the circuit of break-make contact 20. When power supply is cut off the moving system of relay II (PT-40) is pushed into initial position by the return springs. At the same time: contacts 14_1-15_1 close thus preparing the circuit of the winding of relay I (PT-40) for further operation, contacts 16_1-17_1 open and break the electric motor circuit. Contacts 18_1-19_1 close and the electric motor becomes short-circuited via contacts 18-19, 21-20, terminal 16, terminal 5 and terminal 9. After the field winding and the armature winding are short-circuited the electric motor begins to operate as a generator due to the residual (hysteresis) magnetic field induced by the field winding. This causes a strong braking torque considerably reducing the inertial runout of the electric motor.

The electric motor is switched on for left-hand rotation by setting switch II in position I thus causing relay I (PT-40) to operate and close the circuit of the field winding of the electric motor of left-handed rotation via contacts 16-17 of relay I (PT-40). Break-make contact 20 closes with contact 22 thus preparing the circuit for electrodynamic braking.

Design of the PPT-40 Relay

Structurally the relay comprises four main units (Fig. 40): two PT-40 relays (Fig. 44), panel (Fig. 41), switch panel (Fig. 42) and terminal block (Fig.43).

Two screws 20 turned into panel 28 and stand 23 secure two relays PT-40. The PT-40 relay is aligned by two special screws 21 which also faston panel 26 of the PT-40 relay to panel 28 through strip 27 and also to stand 23. Panel 22 of the break-make contact is secured by screw 16. Contact stand 24 is fastened on panel 28 with three screws 1. To prevent screws 1, 16 and 20 from slackening their heads are made to rest on spring washers. Connection to the winding terminals and auxiliary contacts is effected through flexible conductors and to the terminals of the power contacts through rigid bus-bars.

Let us examine each unit separately:

(a) PT-40 relay (See Fig. 44) can also be stripped into separate units and parts.

Relay housing 24 is a cylinder made of steel 10, 2.25 mm thick. It is corrosion-proof due to a glittering zinc coating, 5-8 microns thick, and subsequent chrome passivation. Two semi-circular grooves running on top along its entire length accommodate return springs 30. The cylinder bottom at the end-face is provided with two grooves through which the output leads of coil 29 are passed. Two rectangular grooves running inside the housing along the entire length support spring strips clamping the housing and stands 4 and 26. Housing 24 contains coil 29.

The coil winding is wound around a former made from bakolite chiffon cambric. The winding is made of grade PEL 0.21-mm dia. wire. On top, the winding is coated with varnished silk, type LL2. The former face washer on the side of the output leads is provided with a boss centering the coil

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

in the washer riveted to stand 4. Core 18 travels in sleeve 16 pressed into the former. Sleeve 16 is made of grade Л62 brass tube. The sleeve interior surface is polished to ▽▽▽ 7. Core 18 is made from steel 10. To improve its surface hardness and increase anticorrosion properties, the cone and the cylindrical section are nitrated. The cylindrical section and the cone are polished to obtain surface finish ▽▽▽ 8. Flats provided along the entire length of the cylindrical section are intended to lessen friction. One end of the core is bevelled and the other is shaped as a tang with a M4x0.5 thread. Screwed on the thread is shaped nut 31 made from БрКМц 3-1 bronze. Nut 31 hinge-jointed to lever 17 is employed to adjust the core travel.

Lever 17 is secured on stand 4 by a lockpin around which it can turn. The other end of the lever is connected through a brass axle with carriage 7. Stand 4 is centred, by the washer riveted to it, in the internal hole of housing 24. The opposite side of the housing supports another stand 23 with cylindrical pole 29 riveted to its internal side. The pole has a cut allowing it to be pressed into the sleeve more reliably. The internal bevel in the end section of pole 29 accommodates the cone of core 18.

Lever 6 is hinge-jointed to a steel support riveted to the external side of stand 28. The lever bottom is connected through a pin with carriage 7 while the top secures two return springs 30. The other end of the springs is secured in the holes of stand 4. Both stands 4 and 28 have bent-off lugs for attaching the moving system to the contact panel, the fastening screw being inserted into the small hole and the centering screw, into the large hole.

Carriage 7 is made up of two halves held together by spring locks 8. The carriage windows support three contact silver strips. Strips 10 are spread apart by spring 11, and strip 13 is loaded by two springs 14. Strip 13 is separated from the springs by plastic gaskets.

The entire PT-40 relay assembly is clamped together by two strips 1 whose ends are bent off onto the washers riveted to stands 4 and 28. The relay is covered on top with guard 27 held fast on stands 4 and 28 by the guard material pressed into the stand recesses.

The relay is fastened on the PT-40 contact panel with screws (Fig. 45) The contact panel is made of press powder K-18-2. The panel fittings consisting of four contact stands 3 and six contact strips 2 are pressed into it during manufacture. Contact stands 3 are made of brass ЛС-59-I. The flat section of the stand has a hole into which contact 4 made of pure silver is riveted.

The contacts are riveted to four contact strips 2. Two contact strips serve for joining the coil output leads.

When the relay is mounted on the contact panel the ends of contact strip 10 (See Fig. 44) protruding from the windows touch the contacts on the panel. Contact pressure is created by spring 11. Strip 13 is located between the panel contacts, contact pressure being provided by spring 14. To connect the relay to the external circuit, contact stands 3 (See Fig. 45) are provided with holes, into which the output leads are soldered whereas contact strips 2 have oval windows.

(b) PPT-40 panel (See Fig. 41) is made of black press powder K-18-2. During manufacture bushing nuts 2 made of steel and provided with M3 thread are pressed into the panel. The screws fastening the terminal block and the screws securing the PT-40 relay are turned into these nuts. Terminals 3 and bushings 4 are also pressed into the panel. Terminal 3 made of grade ЛС59-1Тв brass connects the power output leads, for which purpose it is provided with a radial hole of 7.5-mm dia. The power lead is clamped in this hole by a special contact screw turned into the axial threaded hole drilled in the terminal. The hole has a M8 class 2 thread. A galvanic tin-coating, 4-7 microns thick, protects the terminal against corrosion

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

and increases its electric conductivity. The other end of the terminal ends in a cylindrical section to which the contact bus-bars of the PPT-40 relay wiring are soldered.

The special contact screw has a slot for a screw driver on one end and a beaded-in mushroom holding tight the power lead on the other. The mushroom shifts to compress the spring fitted inside the contact screw. This ensures a tight contact and safeguards the power lead against damage. Behind the terminals are plastic partitions safeguarding the bare ends against short-circuit.

Threaded bushings 4 serve for turning in the screws which hold the PPT-40 relay tightly secured on the aircraft.

(c) Switch panel 22 (Fig. 40) is fitted between two panels 26 of the PT-40 relay and is secured with screw 16. Mounted on the panel is a switch controlling the electrodynamic braking circuit of the reversible electric motor. Switch lever 8 is secured on the axle by means of a pressure helical spring. Fitted onto the spring top are washer 1 and safety washer 9 fastening the assembly on the axle.

Lever 8 is actuated by lever 5 through screws 3 which throw over lever 8 when the carriage of the PT-40 relay is in motion. Lever 5 is secured on axle 6 by safety washer 7. Two silver contacts are fitted on lever 8. The other end of lever 8 ends in a point edged at 60° which enters washer 12. Washer 12 rests against spring 13 which is fixed on bevel 15 by washer 14. Such fastening of lever 8 enables it easily to throw over the contacts while spring 13 ensures prompt execution.

The switch panel as such is shown in Fig. 42. It is made of grade K-18-12 compacted powder. Bushings with fitted-in axles and a rivet are pressed during manufacture into panel 5. Axle 4 is made of steel 10 and is protected with a glittering zinc coat resisting corrosion. The axle supports lever with two adjusting screws. Axle 3 is made of

copper M3 and is intended to pass current. For better electric conductivity the axle is silver-coated (a 4-7-micron layer). A lever with a two-way silver contact is secured on the axle. Copper rivets 9 are employed to fasten elbows 2 supporting fixed contacts 8 made of pure silver Cp 99.9. Elbow 2 is made of copper M3. Bevel 1 made of steel 45 is mounted on the protruding section of panel 5. To make the bevel sufficiently hard, it is heat-treated to R_c = 40-45. To safeguard bevel 1 against corrosion, it is cadmium-plated, the thickness of the layer being 3-5 microns.

The terminal block (Fig. 43) is made of grade K-18-2 compacted powder. Four terminals 1 made of L0-59-1TB brass are pressed into the panel. The terminals connect the control circuit output leads. For this purpose they are provided with 3.2-mm dia radial holes. The control circuit output is held in the hole by a special contact screw turned into the axial threaded hole drilled in the terminal. The hole has a M5 thread. A 4-7-microns thick galvanic tin-coat protects the terminal against corrosion and improves its electric conductivity. The other end of the terminal ends in a cylindrical section to which is soldered cable lug 4 made of grade L-62K brass. Conductor 5 of the internal wiring, 0.5 mm^2 in cross-section, grade MGSh-2, is attached to lug 4.

Behind the terminal are supports made of steel 10 which restrict the movement of the external wiring being fastened.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Section II

OPERATING AND MAINTENANCE INSTRUCTIONS

MOUNTING ON AIRCRAFT

The APV-2A automatic system set is arranged on aircraft as follows:

(1) the control unit is installed under the cockpit instrument panel in a horizontal position;

(2) the servomechanism is installed in the fuselage in a vertical position;

(3) the position indicator is mounted on the cockpit panel.

Before mounting the APV-2A automatic system on aircraft, check it for mechanical damage which may be caused during shipment and packing. Examine carefully the dampers of the control unit, locks and seals. Make sure the protective coating is intact, otherwise corrosion may develop. Check condition of the braids, bunched conductors and plug connectors.

Make sure the servomechanism is free of dents, cracks or damaged seals. Examine with utmost care the protective caps on the terminal switches, the condition of switches and check to see that the levers thrust against the buttons of the terminal switches strictly in the centre.

The levers should be corrosion-free and should move smoothly. The methods for removing corrosion are outlined in Supplement 1.

Check the lever for smooth motion as follows: push the lever carefully with a screw driver as far as it will go and then release it. The lever should not jam in the holder and readily return to initial position.

Check to see that the races of the open ball bearings are not dented or damaged and the ball bearings work smoothly.

Check for dents on the position indicator and make sure that the glass is intact.

Correct malfunctions caused during shipment or unpacking.

The control unit can be operated only when secured on a shock-mounted arrangement protecting it against the aircraft vibrations and possible shocks during landing. Type 2730-49-1-2 dampers are used for the purpose.

The control unit is mounted only in a horizontal position with the covers upwards; it is secured on a special plate on four dampers. The plate and the control unit are secured in the cockpit under the instrument panel by special latches.

Handle the control unit carefully when mounting it in the aircraft cockpit. See that the bolts of the dampers are not misaligned since this hampers shock-absorption.

The control unit should be afforded freedom of motion without contacting, however, the cockpit walls or other assemblies during amplitude oscillations of the dampers.

Prior to connecting the aeronavigational air system remove the protective rubber caps from the control unit unions. Connect the static pressure tube to the union marked C_1 and the dynamic pressure tube to the union marked Δ.

When connecting the aeronavigational air system see to it that the dynamic and static pressure lines are joined correctly. Confused or wrong connection of the dynamic and

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

static lines will disturb the operation of the automatic system and render it unserviceable.

Connection to the electric circuit is effected via one plug connector. Check carefully whether the plug connectors are joined correctly to prevent stripping of the thread and crushing of the aligning keys of the plug connectors.

Prior to connecting the control unit to the aeronavigational pneumatic system make sure the system elements are not dirty or damaged and do not contain foreign objects. Check the entire aeronavigational system for proper sealing.

WARNING. During all check-ups of the automatic system see to it that the maximum value of dynamic pressure in the MPI-105 transmitter does not exceed 1000-1100 km/hr at zero altitude.

At an altitude of 10,000 m. the dynamic pressure as indicated by the MVS speed indicator broad pointer should not exceed 930-950 km/hr. While checking the value of dynamic and static pressure in the transmitters see to it that they do not exceed the values indicated above. If otherwise, the sensitive elements of pressure head and flight altitude transmitters may become permanently deformed and the automatic system be rendered unserviceable

When checking the aeronavigational system for airtightness, disconnect the unions of the control unit from this system.

The servomechanism is fastened on aircraft by two suspension journals.

The rod leading to the power booster is attached to an eye ball bearing. The spring of the artificial feel mechanism is connected to its rod.

When mounting the assembly proceed so as not to damage the eye ball bearing; the hinge lines of the servomechanism and the fastening beam of the spring artificial feel mechanism

should be parallel and in one plane. Misalignment of the rod coming from the artificial feel mechanism destroys the race of the eye ball bearing of the servomechanism. When fitting the servomechanism see to it that when the control stick is in extreme positions (against stops) the bunched conductor with the plug connector of the servomechanism is not strained and sags some 10-20 mm.

The overstrained bunch conductor may cause rupture of some current-carrying wires and render the automatic system unfit for service.

It should be borne in mind, however, that excessive sag of the bunch conductor is not desirable since during operation it may interfere with the motion of the servomechanism. Connection to the electric circuit is effected via a plug connector.

The position indicator is mounted on the cockpit instrument panel and is secured therein with four screws. When mounting the position indicator make sure that its terminals have no contact to frame or between each other. Connection to the electric circuit is effected by means of two terminals located in the rear of the position indicator.

When mounting the automatic system make sure that the minus contact (terminal) is properly connected to the body (frame) to ensure reliable operation of the automatic system during shocks and vibration.

After the automatic system has been mounted on aircraft check its operation.

OPERATION

During operation the automatic system should be regularly examined to reduce its fault liability in flight and ensure reliable functioning throughout its service life.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

static lines will disturb the operation of the automatic system and render it unserviceable.

Connection to the electric circuit is effected via one plug connector. Check carefully whether the plug connectors are joined correctly to prevent stripping of the thread and crushing of the aligning keys of the plug connectors.

Prior to connecting the control unit to the aeronavigational pneumatic system make sure the system elements are not dirty or damaged and do not contain foreign objects. Check the entire aeronavigational system for proper sealing.

WARNING. During all check-ups of the automatic system see to it that the maximum value of dynamic pressure in the MPA-105 transmitter does not exceed 1000-1100 km/hr at zero altitude.

At an altitude of 10,000 m. the dynamic pressure as indicated by the KVS speed indicator broad pointer should not exceed 930-950 km/hr. While checking the values of dynamic and static pressure in the transmitters see to it that they do not exceed the values indicated above. If otherwise, the sensitive elements of pressure head and flight altitude transmitters may become permanently deformed and the automatic system be rendered unserviceable

When checking the aeronavigational system for airtightness, disconnect the unions of the control unit from this system.

The servomechanism is fastened on aircraft by two suspension journals.

The rod leading to the power booster is attached to an eye ball bearing. The spring of the artificial feel mechanism is connected to its rod.

When mounting the assembly proceed so as not to damage the eye ball bearing; the hinge lines of the servomechanism and the fastening beam of the spring artificial feel mechanism

should be parallel and in one plane. Misalignment of the rod coming from the artificial feel mechanism destroys the race of the eye ball bearing of the servomechanism. When fitting the servomechanism see to it that when the control stick is in extreme positions (against stops) the bunched conductor with the plug connector of the servomechanism is not strained and sags some 10-20 mm.

The overstrained bunch conductor may cause rupture of some current-carrying wires and render the automatic system unfit for service.

It should be borne in mind, however, that excessive sag of the bunch conductor is not desirable since during operation it may interfere with the motion of the servomechanism. Connection to the electric circuit is effected via a plug connector.

The position indicator is mounted on the cockpit instrument panel and is secured therein with four screws. When mounting the position indicator make sure that its terminals have no contact to frame or between each other. Connection to the electric circuit is effected by means of two terminals located in the rear of the position indicator.

When mounting the automatic system make sure that the minus contact (terminal) is properly connected to the body (frame) to ensure reliable operation of the automatic system during shocks and vibration.

After the automatic system has been mounted on aircraft check its operation.

OPERATION

During operation the automatic system should be regularly examined to reduce its fault liability in flight and ensure reliable functioning throughout its service life.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Regular checks are, as a rule, combined with pre-flight and post-flight inspections of the entire electric equipment, main attention being paid to the reliability of fastening the control unit and servomechanism, input leads, plug connectors and, especially, shielding braids.

After 25 flying hours check the automatic system for correspondence to adjustment law (See Fig. 8).

1. The servo rod downward stroke from the bigger arm of 95-99 mm should begin at a speed of 460-510 km/hr.

2. The servo rod downward stroke should cease at a speed of 880-930 km/hr, the smaller arm being 49-53 mm.

3. The servo rod upward stroke should cease at a minimum speed of 410 km/hr and an arm of 95-99 mm.

4. Number of engagements of the electric motor when speed changes from 460-510 to 880-930 km/hr, and reversely to a minimum of 410 km/hr should be at least 18 on one-way stroke (the rod pulled in or out).

5. The number of engagements of the electric motor when static pressure changes from an altitude of 4700 - 5300 m. to 9650 - 10,350 m. and at a constant speed of 880 - 930 km/hr should be 13-47.

6. An arm corresponding to an altitude of 9650 - 10,350 m. at the end of stroke should be minimum 93 mm.

The results of the automatic system check-up after 25 flying hours are recorded in the table in the certificate accompanying the automatic system. After 50 flying hours lubricate additionally the servo rod with ЦИАТИМ-122-12 grease.

Besides, after 50 hours of the automatic system operation, examine the commutator and brushes of the МУ-100АП electric motor, connection of the leads to the automatic system, and the dampers for proper condition and lubricate the servo rod.

When examining the commutator pay attention to the condition of its contact surface. In normal operation the

commutator surface exhibits a glittering slightly darkened deposit free from traces of carbon and dirt.

On detecting dirt (grease film, frosted, dark deposit) wipe the commutator with a clean cloth dipped in pure gasoline. If this fails to remove dirt clean the commutator with No.200 sandpaper. Never use emery paper. When examining the brushes pay attention to their external condition.

Replace brushes with chips, cracks, poorly dressed wires as well as excessively worn brushes.

When examining the damping system pay attention to the condition of the rubber dampers. On detecting excessively worn rubber or rupture of even one of the four dampers replace them by new ones.

Never operate the system with damaged dampers since this may render the control unit unfit for dervice.

For a normal and trouble-free operation of the АРУ-2А automatic system observe the following rules:

1. When checking the automatic system parameters set a voltage of 28±0.5 V across the aircraft mains or the stand. In this case if the aircraft mains is fed from a ground source, connect a storage battery with a minimum capacity of 28 A/hr in parallel with the power source.

To maintain constant voltage the D.C. source should be provided with a voltage regulator.

2. When checking the automatic system functioning make sure that the supply voltage is within 27±10% V (24.3-29.7 V), the output of the generator supplied from a ground source, not below 1 kW, and the capacity of the storage battery not less than 28 A/hr.

The voltage exceeding 27±10% V may render the automatic system unserviceable.

3. Never start the automatic system whose outfit on aircraft is not complete (e.g. without a position indicator).

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Operation of the automatic system mounted without a position indicator, with short-circuited leads of the position indicator or with contact to the body (ground connection) may result in the burning out of the signalling potentiometer.

4. Never adjust the push rods of the servomechanism terminal switches, as this may wedge the mechanism and make it unfit for use.

5. During any check-up of the automatic system from the automatic control circuits never allow the maximum value of dynamic pressure to exceed 1000-1100 km/hr at zero altitude.

At an altitude of 10,000 m. the dynamic pressure as indicated by the KVC speed indicator broad pointer should be maximum 930-950 km/hr.

During check-ups, the dynamic and the static pressures should not exceed the indicated values. Otherwise, the sensitive elements of the dynamic pressure transmitters may become permanently deformed and render the automatic system unserviceable.

When checking the aeronavigational system for airtightness, disconnect the control unit unions from this system.

Note. When checking the sealing of the aeronavigational system with pressure and rarefactions not exceeding the above values the aeronavigational system may be tested with the transmitters cut in.

6. When operating or testing the system see to it that no moisture is admitted into the cavities of the MPI-106 and MPI-126 transmitters since this may put the transmitters and the automatic system out of repair.

7. During operation the readings of the position indicator and the altitude and flight control navigation instruments may slightly differ due to deviation of atmospheric conditions from the standard values, as well as

due to deviations of the supply current from the nominal rating of 28±0,5 V to the values of 27±10% V.

It should be borne in mind that the position indicator gives the pilot but a general idea of the system operation.

POSSIBLE TROUBLES AND REMEDIES

Trouble	Cause	Remedy
1	2	3
Troubles Detected During Operation		
1. Automatic system fails to operate when actuated manually	(a) No current from aircraft mains	Check supply line and correct trouble
	(b) No or poor contact in plug connectors	Obtain reliable contact in plug connectors
	(c) No or poor contact to frame	Obtain reliable contact to frame
	(d) Circuit of PPT-40 relay windings broken	Remove automatic system set from aircraft and send it to repair shop
	(e) Broken circuit of relay contacts 14 and 15 or dirty contacts	Same
2. Automatic system fails to operate when actuated automatically	(a) Clogged or faulty tubes of aeronavigational air system	Scavenge air system tubes and correct trouble

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

1	2	3
	(b) Confused connection of dynamic and static tubes of air system to control unit unions	Check connection of dynamic and static tubes of air system to control unit unions. If automatic system has been tested with dynamic and static tubes misconnected, remove automatic system set and send it to repair shop
	(c) Circuit of feedback potentiometer in servomechanism mismatch transmitter broken or absent	Remove automatic system set from aircraft and send it to repair shop
	(d) Circuit of potentiometer of MPД-106 or MPД-126 transmitters broken or absent	Same
	(e) No contact between brush and potentiometer of MPД-106 transmitter due to moisture or corrosion	Same
	(f) No contact between collar and winding of voltage divider (ПЭВ-25Х-510 ohms)	Same

1	2	3
	(g) РПС relay fails to operate	Remove automatic system set from aircraft and send it to repair shop[x]
3. No response to speed changes	(a) No contact between brush and potentiometer or broken circuit of МРД-106 transmitter potentiometer.	Same
	(b) No contact between slide and feedback potentiometer or broken potentiometer circuit Broken winding 5-6 of РПС relay	Same
4. No response to altitude changes	(a) No contact between brush and potentiometer or broken circuit of МРД-126 transmitter potentiometer	Remove automatic system set from aircraft and send it to repair shop[x]
	(b) Puncture or deterioration of selenium rectifier assembly	Same
	(c) Broken winding 1-2, 3-4 of РПС relay	Same
5. Failure of position indicator during automatic system operation	(a) No contact between slide and position indicator potentiometer of servomechanism mismatch transmitter or broken potentiometer circuit	Remove booster system set from aircraft and send it to repair shop[x]

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

1	2	3
	(b) Broken winding of position indicator	Replace position indicator
6. At the end of servo rod stroke to BIGGER ARM warning lamp of take-off and landing position fails to flash on	(a) Faulty warning lamp	Replace warning lamp
	(b) Faulty terminal switch of servomechanism BIGGER ARM	Remove automatic system set and send it to repair shop[x]
	(c) Circuit 1-8 of servomechanism plug connector absent or broken	Same
	(d) Disturbed adjustment of terminal switch push rod	Same
	(e) Inaccurate adjustment of automatic system	At BIGGER ARM the warning lamp may not burn if the arm of servomechanism to booster at the end of the stroke is not less than 99 mm by height. For this purpose disconnect servomechanism from aircraft electric mains and measure the arm on test device (See Fig.74)
7. Servomechanism rod wedges	(a) Disturbed adjustment of terminal switch push rod of BIGGER or SMALLER ARM	Remove automatic system set from aircraft and send it to repair shop[x]

1	2	3
	(b) Faulty terminal switch of BIGGER or SMALLER ARM	Remove automatic system set from aircraft and send it to repair shop[x]
	(c) Unpromt operation of PPT-40 relay No electrodynamic braking	Same
	(d) Broken field winding or short-circuited armature of MY-100AII electric motor of the servomechanism	Same
	(e) Sticking of MY-100AII electric motor brushes due to excessive wear or swelling	
8. No electrodynamic braking of electric motor of automatic system servomechanism	(a) No contact of MY-100AII electric motor to frame (minus)	Check contact to frame and correct fault
	(b) Jamming of PT-40 relay core during dropout, i.e. contacts 16-17 fail to close	Remove automatic system set and send it to repair shop[x]
	(c) Disturbed adjustment of PPT-40 relay beam, i.e. beam fails to change over switch	Same

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

1	2	3
	contacts when relay operates (d) Dirty contacts 16-17 of PPT-40 relay	Remove automatic system set and send it to repair shop[X]
	(e) No contact between terminals 8 and 9 or 8 and 5 of PPT-40 relay due to deterioration of contacts 16-17 or contact segment	
9. Servomechanism rod does not shift	(a) Armature of MP-100AM electric motor does not rotate (short-circuited or burnt field winding or armature winding)	Remove automatic system set and send it to repair shop[X]
	(b) Broken blade of output shaft of electric motor armature	Same
	(c) Servomechanism rod wedges at BIGGER or SMALLER ARM	Same
	(d) Sticking of electric motor brushes in brush-holders due to excessive wear or swelling	

1	2	3
	(e) No engagement between output shaft of electric motor and reduction gear	Remove automatic system set and send it to repair shop[X]
	Faults Arising during Assembly and Adjustment	
1. Automatic system is not actuated manually	Terminals 9 and 10 or 9 and 5 of control unit plug connector confused during assembly	Rearrange in accordance with wiring diagram
2. Automatic system is not actuated automatically	(a) No connection between terminal 8 of PPT-40 relay and PC-3 relay winding of SMALLER ARM	Correct fault
	(b) Terminals 3 and 7 or 3 and 5 of control unit plug connector confused during assembly	Check and correct fault
3. No response to speed changes	(a) Faulty selenium rectifier	Replace selenium rectifier
	(b) Output leads of MPA-106 and MPA-126 transmitters confused in place of connection	Check and correct fault
	(c) Faulty PMC relay	Replace PMC relay

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

1	2	3
4. No electrodynamic braking during automatic system operation	a) Broken circuit of terminal 8 of PPT-40 relay leading to terminal of control unit plug connector	Check and correct malfunction
	(b) Unprompt operation of PPT-40 relay	Replace PPT-40 relay
	(c) Faulty MPÄ-I06 transmitter	Replace MPÄ-I06 transmitter
5. Series of fast makes and breaks (crackling) of PC-3 relay during system operation		
6. During automatic system operation servomechanism rod moves in opposite direction	(a) Wrong connection of SMALLER ARM PC-3 relay	Check and correct malfunction
7. Servomechanism rod wedges at BIGGER ARM	Terminals 1 and 12 of control unit plug connector confused during assembly	Check and correct malfunction
8. When automatic system is actuated automatically servomechanism rod does not reach BIGGER ARM	Contact between collar and winding of voltage divider (MÄB-25X-5I0 ohms) disturbed or absent	Check and correct malfunction

1	2	3
9. Chattering on automatic system operation in response to speed and altitude changes	(a) Terminals 11 and 12 of PHC relay confused	Check and correct malfunction
	(b) Faulty MPÄ-I26 transmitter	Replace MPÄ-I26 transmitter
10. Automatic system operation in response to altitude change does not cease	(a) Faulty MPÄ-I26 transmitter	Replace MPÄ-I26 transmitter
	(b) Output leads of MPÄ-I06 and MPÄ-I26 transmitters confused in place of connection	Check and correct malfunction
11. Large operational range in response to speed changes	(a) Faulty MPÄ-I06 transmitter	Replace MPÄ-I06 transmitter
	(b) Terminals 6 and 7 in control unit plug connector confused	Check and correct malfunction
12. Automatic system prematurely stops when operating in response to altitude changes	Terminals 4 and 5 of PHO relay confused	Check and correct malfunction

Note: Operations marked by an asterisk in the table should be performed only in specialised workshops.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

MAINTENANCE OF THE APV-2A CONTROL UNIT

The APV-2A control unit removed from the aircraft because of a malfunction which cannot be corrected without disassembly should be sent to a repair shop. In the repair shop the control unit is cleaned from dust and dirt, carefully examined from the outside and then disassembled.

Disassembly of the APV-2A Control Unit

The APV-2A control unit is disassembled into ten main components (See Fig. 16):

(1) [illegible] small-size potentiometer transmitter 49;
(2) [illegible] small-size potentiometer transmitter 53;
(3) PNC polarized relay 43 with block 11;
(4) [illegible] power relays 7;
(5) [illegible] reversing and braking relay 27;
(6) [illegible] with type BC-0.5 resistors 12;
(7) Adjustable resistor NOE-25X-510 ohms (3);
(8) [illegible] selenium rectifier 3;
(9) Capacitor MBTM-3-160-2x0.5 10;
(10) Plate 17 with dampers 273049-1-2 44.

The control unit can be disassembled in any sequence. However, prior to removing the above mentioned components, remove plate 17 with dampers 44, hood 30 and cover 13.

Depending on the nature of the malfunction the control unit is disassembled completely or in part. In their turn, the removed components of the control unit can be stripped into smaller separate parts.

Stripping of the Control Unit into Components

Disassembly of the control unit is performed in the following sequence:

Operation 1. Remove plate 17 with dampers 44.

1. Turn off eight screws 45 with a screw-driver through special holes provided in plate 17 and detach plate 17 with dampers 44.

Operation 2. Remove the small-size potentiometer transmitters MPД-I06 49 and MPД-I26 53.

1. Remove wire 51 with seal 50.
2. Turn off three screws 52 and remove hood 30.
3. Turn off two screws 47 and remove cap 38.
4. Turn off two screws 54 and remove clamp 55.
5. Pull off wire mesh 35 to bare the soldered joint. Push the vinyl chloride sleeves protecting the soldered joints up along the conductors.
6. Unsolder the wires leading to the small-size potentiometer transmitters from terminals 13, 14, 15, 16, and 17 of terminal block 40 (See wiring diagram of the APV-2A control unit in Fig. 23).
7. Turn off five screws 37 and detach the small-size potentiometer transmitters MPД-I06 49 and MPД-I26 53.

Operation 3. Remove cover 13.

1. Turn off five screws 19 holding nuts 29 and 46 with a spanner.
2. Turn off eight screws 14 and detach cover 13.

Operation 4. Remove PNC relay 43.

1. Turn off two screws 22 holding the nuts with a spanner and remove holder 20.
2. Detach PNC polarized relay 43 from its block 11.

Note. Detach the polarized relay from the block carefully so as not to damage the wires. It is advisable to detach the relay from the block with a screw-driver inserted between them.

Operation 5. Remove PPT-40 reversing and braking relay 27.

1. Turn off screw 25 and remove clamp 24.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

2. Turn off four screws 26 and remove reversing and braking relay PPT-40 27.

3. Slacken screws at the terminals of this relay and detach the wires.

4. Remove vinyl chloride sleeves 23 from the bunched conductor.

Operation 6. Detach panel 21 from base 16.

1. Turn off four screws 20 and detach panel 21 from base 16.

Operation 7. Remove terminal block 40 from the recess in base 16.

1. Turn off the nut 41 with a special spanner and slightly pull terminal block 40 from the recess in base 16.

Operation 8. Remove capacitor MBTM-3-160-2x0.5(10)

1. Turn out two screws 9 and remove capacitor 10.

2. Shift the vinyl chloride sleeves protecting the soldered joints from the capacitor terminals onto the wires.

3. Unsolder five wires from the capacitor terminals.

Operation 9. Remove ABC-1-53 selenium rectifier 8.

1. Turn out the nut of selenium rectifier 8 and remove the rectifier.

2. Shift the vinyl chloride sleeves protecting the soldered joints from the terminals of the selenium rectifier onto the wires.

3. Unsolder two wires from the selenium rectifier terminals.

Operation 10. Remove adjustable resistor ПЭВ-25х-510 25 -> 10 ohm 3.

1. Turn off screw 5 and remove adjustable resistor 3.

2. Remove two bushings 4 from the adjustable resistor.

3. Shift the vinyl chloride sleeves protecting soldered joints from the terminals of the adjustable resistor onto the wires.

4. Unsolder four wires from the terminals of the adjustable resistor.

Operation 11. Remove two PC-3 relays 7.

1. Unsolder one wire of resistor R_4 12 and one wire of resistor R_3 (wires leading to the PC-3 relay).

2. Turn off four screws 6 and remove two PC-3 relays.

Operation 12. Remove panel 2.

1. Unsolder resistors R_1, R_2, R_3, R_4, R_5 and R_6 from terminals of panel 2.

2. Unsolder all wires from the terminals of panel 2.

3. Turn off two screws 1 and remove panel 2.

Operation 13. Remove the block of PEC polarized relay 11.

1. Unsolder the wire leading to the PEC relay block from terminal 6 of terminal block 40 and remove the block of the PEC relay.

Unsolder the damaged wire from the control unit terminals and replace it by a new one.

If necessary, in addition to the above operations, remove also plug connector 31. To do this:

1. Turn off the terminal nut of the plug connector on the side of the bunched conductor.

2. Pull off wire mesh 35 together with union 32 and clip 34 to bare the soldered joint.

3. Pull the vinyl chloride sleeves protecting the soldered joints from the pins of the plug connector onto the wires.

4. Unsolder the wires from the pins of the plug connector.

Fault-Finding

Before locating faults blow off the assembly removed from the control unit with compressed air and wipe all

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

2. Turn off four screws 26 and remove reversing and braking relay PPT-40 27.

3. Slacken screws at the terminals of this relay and detach the wires.

4. Remove vinyl chloride sleeves 23 from the bunched conductor.

Operation 9. Detach panel 21 from base 16.

1. Turn off four screws 28 and detach panel 21 from base 16.

Operation 9. Remove terminal block 40 from the recess in base 16.

1. Turn off sleeve nut 41 with a special spanner and slightly pull terminal block 40 from the recess in base 16.

Operation 9. Remove capacitor MBTH-3-160-2x0.5(10)

1. Turn off two screws 9 and remove capacitor 10.

2. Shift the vinyl chloride sleeves protecting the soldered joints from the capacitor terminals onto the wires.

3. Unsolder five wires from the capacitor terminals.

Operation 9. Remove ABC-10-53 selenium rectifier 8.

1. Turn off the nut of selenium rectifier 8 and remove the rectifier.

2. Shift the vinyl chloride sleeves protecting the soldered joints from the terminals of the selenium rectifier onto the wires.

3. Unsolder two wires from the selenium rectifier terminals.

Operation 10. Remove adjustable resistor ПЭВ-25х-510 25 ± 10 ohms 3.

1. Turn off screw 5 and remove adjustable resistor 3.

2. Remove two bushings 4 from the adjustable resistor.

3. Shift the vinyl chloride sleeves protecting soldered joints from the terminals of the adjustable resistor onto the wires.

4. Unsolder four wires from the terminals of the adjustable resistor.

Operation 11. Remove two PC-3 relays 7.

1. Unsolder one wire of resistor R_4 12 and one wire of resistor R_3 (wires leading to the PC-3 relay).

2. Turn off four screws 6 and remove two PC-3 relays.

Operation 12. Remove panel 2.

1. Unsolder resistors R_1, R_2, R_3, R_4, R_5 and R_6 from terminals of panel 2.

2. Unsolder all wires from the terminals of panel 2.

3. Turn off two screws 1 and remove panel 2.

Operation 13. Remove the block of PEC polarized relay 11.

1. Unsolder the wire leading to the PEO relay block from terminal 6 of terminal block 40 and remove the block of the PEC relay.

Unsolder the damaged wire from the control unit terminals and replace it by a new one.

If necessary, in addition to the above operations, remove also plug connector 31. To do this:

1. Turn off the terminal nut of the plug connector on the side of the bunched conductor.

2. Pull off wire mesh 35 together with union 32 and clip 34 to bare the soldered joint.

3. Pull the vinyl chloride sleeves protecting the soldered joints from the pins of the plug connector onto the wires.

4. Unsolder the wires from the pins of the plug connector.

Fault-Finding

Before locating faults blow off the assembly removed from the control unit with compressed air and wipe all

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

external surfaces with a clean cloth. Then examine the assembly from the outside and check the ohmic resistance of the windings as well as the insulation resistance.

1. Check during external inspection:

(a) presence of all parts of the assembly in conformity with the drawing;

(b) condition of their surfaces: check for cracks, dents, broken parts, damaged insulation of the coils and output leads, corrosion on the contact bus-bars and friction faces;

(c) condition of the contacts, make sure they are clean and without excessive carbon deposit;

(d) the relay moving systems for smooth operation (slightly push the relay armature with a finger) and condition of the springs.

2. Check the ohmic resistance of the windings. The winding data are given in the Section "Specifications". The values of the winding resistance are true for an ambient temperature of +20°C.

3. Check the insulation resistance of the current-carrying parts relative to the body with a 500-V megger: place one prod of the megger onto the body and connect the other consecutively to all outputs and bus-bars. When cold the insulation resistance should be minimum 2 megohms.

Note down all troubles revealed during inspection and tests in the defects sheet.

Depending on the nature of the trouble the unit can be disassembled completely or in part.

MAINTENANCE, FAULT-FINDING, DISASSEMBLY, ASSEMBLY, ADJUSTMENT AND TESTING OF AUTOMATIC SYSTEM COMPONENTS

MPI-106 and MPI-126 Transmitters

Maintenance

The transmitter removed from the control unit because of a malfunction which cannot be corrected without disassembly is sent to specialized repair shops. The repair shops should be provided with all necessary tools, equipment and devices.

Fault-Finding

Prior to locating faults remove dust and dirt from the transmitter and wipe its external surfaces with a clean cloth. Then check by external inspection:

(a) outfit - presence of all parts;

(b) condition of the transmitter surface; check for cracks and dents on the body, base or unions and also for damaged or corrosive insulation of the output leads.

Checking the Insulation Resistance

Use a 500-V megger to check the insulation resistance of the current-carrying parts relative to the housing. Place one prod of the megger onto the housing or base at a point where paint has been removed in advance and connect the other to the output leads linked together. The insulation resistance should be minimum 2 megohms.

Checking the Potentiometer Resistance

Check the potentiometer resistance with a tester (TT-1 or TT-2) or any other device. The tester prods are

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

connected to terminals A and B (See Fig.27). The resistance should be within 1000±200 ohms. If the potentiometer resistance is above or below this figure replace the potentiometer.

If the value of the potentiometer resistance conforms to the indicated value, proceed to check the transmitter calibration.

Checking the Transmitter Calibration

To calibrate the transmitter, determine the relative resistance value produced by the transmitter at pressure values under test, i.e the dependence between the measured pressure and the transmitter output relative resistance. The value of the transmitter relative resistance is found on an electric plant.

The checking and calibration of the transmitter based on the property of balanced bridge which equalizes the relative resistance of its arms when the current across galvanometer Г (Fig.46) is equal to zero.

$$\frac{R_1}{R_1+R_2} \times 100\% = \frac{R_3}{R_3+R_4} \times 100\%$$

The electric circuit for calibrating, adjusting and testing the transmitter is shown in Fig. 47.

The plant whose electric circuit is represented in Fig. 47 is used to take measurements of the relative resistance values produced by the transmitter in per cent. The plant is mounted on a special panel with ten pairs of wire-wound resistors attached to its bottom. The total value of each pair of resistors is 900 ohms. The inputs of each pair of the wire-wound resistors are interconnected and brought out onto the panel while their outputs are brought

out onto the upper part of the panel and are arranged as sockets marked with figures: 0, 10, 20, 30, 40, 50, 60, 70, 80, 90. Mounted on the upper part of the panel is a 100-ohm rheostat. The rheostat slide is also brought out onto the panel.

The markings on the panel terminals should correspond to the markings of the transmitter output leads.

The rheostat can be cut in via a plug between any two wire-wound resistors. The total resistance of each pair of the wire-wound resistors and the rheostat equals 1000 ohms while the rheostat resistance is 100 ohms. In this way the movement of the rheostat slide from one extreme position to the other changes the relative resistance of the plant by 10%. The rheostat scale along which the slide moves makes it possible to take readings of the relative resistance variations every 1%. The plant error does not exceed 0.2%.

To test and calibrate the transmitter, use the circuit shown in Fig. 47. All joints of the hoses should be reliably sealed.

Transmitters of the aneroid type (МРД-126) are calibrated as follows.

Operate cock 4 (Fig.47) to create in the system a rarefaction indicated by mercury barometer 5 corresponding to the first calibrated point, i.e. 450 mm Hg abs. Shut cock 4, insert the plug of electric plant 8 into the sockets marked 0 and shift the slide along the potentiometer until the zero galvanometer pointer indicates 0. The total value of the numbered markings in per cent taken against the slide index and at the sockets with the inserted plug corresponds to the relative resistance of the first calibrated point. The value of the relative resistance at the first point should be minimum 0.3%.

Then proceed to check the calibration of the last point, i.e. 200 mm Hg abs. For this purpose insert the plug of electric plant 8 into the sockets marked 90.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

The value of the relative resistance for the last point should not exceed 99.7%.

The length of the brush swing along the potentiometer should be such that the difference between the relative resistance at the maximum pressure and the relative resistance with zero pressure is not below 92%.

The transmitter of the barometer type MPД-106 is calibrated in the same way as the MPД-126 transmitter, the created pressure being measured by a pressure gauge instead of a mercury barometer.

The calibration and determination of the relative resistance produced by the transmitter are performed when the transmitter is subjected to test vibration under a vibration load of 0.1 to 0.3 g.

In the absence of vibration slightly tap the transmitter before taking readings.

During the test maintain a temperature of 20±5°C. Standard pressure gauges (barometers) should be kept in normal conditions without being subjected to test vibration.

During calibration, check the cause of the transmitter trouble.

To carry out the above checks, the following measuring equipment is required:

(a) standard pressure gauges (barometers) of class 0.35, their measurement range exceeding that of the transmitter by maximum 30%;

(b) class 0.5 resistance bridge or TT-1 or TT-2 tester;

(c) a 500-V D.C. megger;

(d) zero galvanometer;

(e) mounting parts (cocks, pipes, wires, etc.).

Disassembly of the Transmitter

Depending on the nature of the trouble the unit can be disassembled completely or partially.

Partial Disassembly of the Transmitter

Turn off housing 17 (See Fig. 28), remove two nuts 16 with the washer and gasket 14 from union 15.

To detach plate 24 with the mechanism from base 26, turn out two screws 59 and remove strap 39; then unsolder the output leads from plug 38 and remove two nuts 28 with the washer from union 30.

Complete Disassembly of the Transmitter

Remove the lockpin from rod 7. Turn out nut 3 and remove the washers to detach the unit of the sensitive element. Remove potentiometer 21 pulling out safety washer 53 from the groove of adjusting screw 19 and turning out adjusting screw 19, remove flat spring 13 used to take up play in the potentiometer unit and disassemble axle 42. Use a split socket to remove return spring 9 and current-carrying spring 10; slacken screws 52 and 54 to remove brush holder 57 with brush 56 and plug 45 from axle 42. Turn out screws 44 and remove the insulating gasket.

Examine separate units and parts of the transmitter thus disassembled and replace them in the repair shop, if necessary.

Disassembly of the transmitter into separate parts makes it possible to utilize those in good repair to the best advantage.

Assembly of the Transmitter

After the transmitter has been disassembled and its separate units examined, replace the faulty parts and proceed to assembly.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

First, remove dust and dirt from all parts and wash them in gasoline.

Polish the working surface of the potentiometer with ГОИ paste applied to a soft cloth tampon or a piece of shammy. The remains of the paste are washed off with gasoline.

After polishing check the potentiometer resistance by the method outlined above. The resistance should be 1000±200 ohms. The transmitter assembly is the reverse of disassembly. During assembly pay special attention to backlash which should be as small as possible but at the same time should preclude strong friction. After the transmitter has been assembled check the insulation resistance of its electric elements by the above-described method.

Then adjust the transmitter.

Adjusting the Transmitter

The circuit used for adjustment of the transmitter is identical to that used for calibration (See Fig. 47).

To adjust the first point, insert the plug into the first pair of the sockets of electric plant 8 and set the potentiometer slide at the scale zero. Then shift the transmitter potentiometer until the pointer of the zero galvanometer is adjacent to the zero mark of its scale and shift the slide of the plant to align the zero galvanometer pointer with the zero on its scale. The transmitter potentiometer is shifted by means of adjusting screw 19 (See Fig. 28) or rod 7.

The first point is considered adjusted if the value of the relative resistance is minimum 0.3%. After adjusting the transmitter at the zero point, adjust the brush travel range along the transmitter potentiometer with pressure changing from zero to maximum within the adjustment range (See Section "Specifications"). For this purpose build up in the transmitter a pressure corresponding to the maximum measured pressure and insert the plug into the last pair of the electric plant sockets.

The brush travel range along the potentiometer is considered adjusted if the difference between the relative resistance at the maximum pressure within the measurement range of the given transmitter and the relative resistance with zero pressure is minimum 92%. Then adjust the transmitter again at zero pressure and check the brush travel.

After adjustment tighten all screws, secure them with nitroglue AK-20 and paint with nitroenamel.

Checking for Airtightness

Check for airtightness as follows:

Connect both unions of the type МРТ-100 transmitter via a T-piece with a source of pressure (vacuum) and with a reference barometer (pressure gauge).

Create in the system a pressure (vacuum) of 10 mm Hg abs. and watch the readings of the pressure gauge (barometer) for one minute. During this period the pressure drop should not exceed 6 mm of mercury at a temperature of +20°C.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Checking Continuity of Contact Between the Brush and Potentiometer

To check contact for continuity, proceed as follows. Feed 3-V D.C. to terminals A and B of the transmitter (See Fig.27) and connect a type MIM-46 voltmeter with a measuring capacity of 3 V to terminals A and B. Then connect the transmitter to the air system of the test desk and gradually changing pressure (or vacuum) in the transmitter within the range indicated in the Section "Specifications" watch the oscillations of the voltmeter pointer.

The test results are satisfactory if the oscillations of the oltmeter pointer at the beginning of the scale do not exceed 0.04 V and at the end - 0.1 V.

PEC Polarized Relay

Fault-Finding

Remove dust and dirt from the PEC polarized relay detached from the control unit and wipe the external surface with a clean cloth. Then check by external examination:

(a) outfit - presence of all parts;

(b) condition of the surfaces; make sure there are no cracks, dents, broken parts, corrosion on the output bus-bars, etc.

Checking the Insulation Resistance

Use a 100 - 200-V D.C. megger to check the insulation resistance of the current-carrying parts relative to the frame.

Place one prod of the megger onto the frame and connect the other consecutively to the current-carrying bus-bars (See Fig.30). When cold, the insulation resistance should be minimum 2 megohms; if the insulation resistance is below that minimum replace the relay.

Checking Resistance of the Windings

Check the resistance of the windings with a TT-1 or TT-2 tester or any other device. The tester prods are connected to the output bus-bars of the respective winding (See Fig.30). The values of the winding resistance are given in the Section "Specifications" as calculated for a temperature of 20°C. If the resistance of even one winding, except for winding V, is above or below the rated value replace the relay.

If the winding resistance, except for winding V, conforms to the indicated values, check the electrical parameters of the cold relay (by the method outlined below) and simultaneously find the cause of the relay trouble.

Disassembly

Due to the complexity of design and adjustment the relay should never be disassembled. A defective relay is subject to replacement.

Checking the Relay Parameters

Connect the relay to the desk circuit (Fig.48) via a connector block.

Prior to mounting the relay on the desk set all switches at OFF (ВЫКЛ/ТЕЛО) and increase the resistance of potentiometer R_1 to the maximum value.

The circuit shown in Fig.46 is designed for a power supply from a storage battery or any other 2-3-V D.C. source. The voltage is measured by voltmeter V. Never increase supply voltage in the circuit since resistors R_2, R_3, R_4 and R_6 cut in series with the relay windings are intended only for 2-3 V.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Supply voltage can be increased only after reconversion of these resistors.

Check the relay pickup current as follows:

Turn on switches B_1 and B_2 and set switches $П_I$ and $П_2$ in position 1. Gradually increasing voltage by potentiometer R_1 determine the relay pick-up current during the rightward operation by milliammeter mA. The milliammeter should have scale with the zero marking in the middle since a change in the direction of the current flow along the relay windings will cause the milliammeter pointer to deflect to the right or left.

If a milliammeter with the zero in the middle is not available, use any other milliammeter, making sure to change over the wires leadings to the instrument terminals.

Operation of the relay rightwards is indicated by warning lamp $Л_1$ which flashes on or goes out. Set the slide of potentiometer R_1 in the initial position. To determine the relay pickup current during the leftward operation, set switch $П_1$ in position 2 (switch $П_2$ in position 1) and gradually raising voltage by potentiometer R_1 read the relay pickup current from milliammeter mA. Operation of the relay leftwards is indicated by warning lamp $Л_2$. Set the potentiometer slide in the initial position, fix switch $П_I$ in position 1 and turn off switch B_2.

To determine the pickup current from winding II set switch in position 2. The pickup current from winding II and other windings is determined in the same way as from winding I after setting switch $П_2$ in positions corresponding to each winding. The values of the relay pickup current from each winding are given below:

No. of winding	Markings on block	Pickup current in mA	
		rightwards	leftwards
I	1-2	0.39-0.75	0.39-0.75
II	3-4	0.39-0.75	0.39-0.75
III	5-6	0.11-0.22	0.11-0.22
IV	13-12	17-33	17-33
V	11-12	2.8-5.5	2.8-5.5

After checking the pickup current, check the electric strength of the insulation. For this purpose apply 375 V from an A.C. source of 50 c.p.s. to the frame and current-carrying parts and between the windings, and 75 V between the contacts; maintain this voltage for one minute at each pair of the points.

The results are considered to be satisfactory if during the test the insulation and coverings were not punctured.

Note. When checking the electic strength of the insulation, gradually increase voltage up to the indicated value, maintain it at this level for one minute and then decrease it to 1/3 of its value and cut it off.

PC-3 Power Relay

Repair

A PC-3 relay removed from the control unit due to malfunction which cannot be corrected without repair should be sent to specialized repair shops. The repair shops should be provided with all necessary tools, equipment and devices.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Fault-Finding

Prior to fault finding blow off the relay with compressed air, remove dust and dirt and wipe the external surface with a clean cloth. Then check by external inspection:

(a) outfit - presence of all parts;

(b) condition of the surfaces; make sure there are no cracks, dents, broken parts, damaged insulation of the coil and output leads, corrosion on the contact bus-bars and friction faces;

(c) condition of the contacts; make sure they are clean and without excessive carbon deposit, melting and sticking of contacts are not permissible.

(d) the moving system for smooth operation (slightly push the relay armature with a finger), as well as condition of the spring and locked screws and nuts.

Checking the Insulation Resistance

Use a 500-V megger to check the insulation resistance of the current-carrying parts relative to the base; place one prod of the megger onto the base and connect the other consecutively to the current-carrying terminals (See Fig.34). When cold, the insulation resistance should be minimum 2 megohms.

Checking the Winding Resistance

Check the winding resistance with a tester (TT-1 or TT-2) or any other device. The tester prods are connected to the output lugs (See Fig.34). Resistance should be within 130.5-159.5 ohms. If the winding resistance is above or below this figure replace winding 5 (See Fig.35) together with base 3.

The new winding is borrowed from the Spare Parts, Tools and Accessories set if it is available, otherwise, use windings from other relays of this type received for repair.

If the winding resistance conforms to the above indicated values, check the electric parameters of the cold relay (by the method outlined below).

Simultaneously, find the cause of the relay trouble.

Disassembly

Disassemble the relay in the following sequence:

1. Remove the armature (assembly) and the spring with the rest; to this end:

(a) unsolder connecting flexible lead 23 (See Fig 35) from the lug of armature 8 with a small soldering bit;

(b) remove protective clamp 6 and pull out armature 8 with contact spring 9;

(c) turn out screw 2 and remove spring 4 with the rest.

2. Remove the fixed contact segments with the contacts from the base, for which purpose:

(a) unsolder leads 21 of the coil from output bus-bars 17 with a small soldering bit;

(b) turn out screws 15 and carefully remove strap 14, fixed contact segments 10 and 11, gaskets 12 and 18 and output lugs 17.

Separate parts of the relay stripped in this manner can be checked for faults and replaced in the repair shop. Disassembly of the relay into separate parts makes it possible to utilize those in good repair to the best advantage.

When disassembling the relay see to it that the tiny parts are not lost.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Assembly

After the relay has been disassembled and its separate parts examined, replace the faulty parts and proceed to assemble the relay. First remove dust and dirt from all parts, polish the contacts and wash them in alcohol. Polish on a soft felt disc with ГОИ paste.

The relay assembly is the reverse of disassembly.

When assembling the armature unit check the force with which contact spring 8 breaks away from gasket 5 (See Fig.37); the force should be within 110-150 gr. This force is obtained by bending contact spring 8 in point 6.

After the relay has been assembled check the contacts for axial alignment.

Adjust the contact alignment by bending fixed contact bus-bars 10 and 11 at the base without disturbing the tight joint with gasket 12 (See Fig.35).

Adjusting Contact

1. Obtain a magnetic gap of 0.8-0.9 mm between armature 3 and core 7 (See Fig. 35). The gap size is adjusted by bending contact bus-bar 10. The gap is measured along the axis of core 7 and is checked by means of a set of feeler gauges.

2. Adjust a gap of 0.92-1.08 mm between the contacts. The gap between the contacts is checked by means of a set of feeler gauges and is adjusted by bending bus-bar 11. Bend the bus-bar by small pliers with long jaws.

Adjusting the Relay

1. Adjust the tension of the return spring at the moment of the armature starting. With the magnetic gap

equalling 0.3-0.9 mm the starting effort should be within 40-60 gr. It is checked with a pressure dynamometer. The moment of the armature starting is indicated by a warning lamp cut in between the normally closed contacts.

Adjustment should be performed with the help of a set of shims 1 placed under screw 2 (See Fig.35).

2. Cut the relay into the circuit (Fig.49) and check contact pressure.

Measure contact pressure at 23 V across the winding; the voltage is indicated by voltmeter V_1. For this purpose start the generator and operate rheostat R_2 to obtain 23 V on voltmeter V_2. Turn on switches B_1, B_2 and B_3. Adjust the voltage by potentiometer R_2.

The value of contact pressure is recorded by the dynamometer scale at the moment the contacts break.

Fix the dynamometer special hook on both sides of the moving contact in the contact centre. The moment of the contact breaking is indicated by warning lamp $Л_2$ which goes out as the moving contact departs from the fixed contact.

Contact pressure for normal operation should be minimum 70 gr.

Contact pressure is adjusted by changing the magnetic gap within the tolerance limit. Besides contact pressure check also the pressure travel which should be minimum 0.15 mm. Check the pressure travel as follows: fit a 0.15 mm feeler gauge between the armature and the core, switch on the energized relay until the contacts close completely and watch warning lamp $Л_2$ which should flash on if the pressure travel is sufficient.

3. Adjust the relay pickup current. For this purpose cut the relay into the circuit (See Fig.49) and turn out switch B_2.

Gradually increasing the voltage and watching the readings of milliammeter mA record the relay pickup current

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

indicated by flashing on of warning lamp $Л_2$. The relay pickup current must not exceed 90 mA.

The pickup current is adjusted by changing the magnetic gap, contact gap and contact pressure within the tolerance limit. At a retarded switching-on (pickup current over 90 mA) reduce the gap and, conversely, at a premature switching-on, increase it.

Pickup current can likewise be adjusted by changing the tension of the return spring by means of washers.

4. Adjust the relay dropout current. After checking the relay pickup current, gradually decrease the voltage across the winding and, watching the readings of the milliammeter, record the relay dropout current. The relay switching-off is indicated by flashing on of warning lamp $Л_1$.

Dropout current should be minimum 25 mA. It is adjusted in the same manner as pickup current.

After adjusting the relay pickup and dropout current check again:

(a) contact pressure which should be: within 40-60 gr for the normally closed contacts and minimum 70 gr for the normally open contacts at 23 V across the relay winding;

(b) contact gap which should be within 0.92-1.08 mm;

(c) magnetic gap which should be within 0.8-0.9 mm;

(d) contact pressure travel which should be minimum 0.15 mm;

(e) tension of the return spring at the moment of the armature starting (along the core axis) which should be within 40-60 gr.

After checking, test the relay.

Testing the Relay

Before testing examine the relay and check the standard of assembly, external finish and markings.

When checking the operation and ratings, measure the insulation resistance of the current-carrying parts relative to the frame with 500-V megger. The insulation resistance should be minimum 2 megohms.

After this, connect the relay to the desk circuit (See Fig.49) using the clamps for the purpose.

Before mounting the relay onto the test desk set all switches at OFF (ВЫКЛЮЧЕНО) and increase the resistance of all rheostats to the maximum value.

Start generator Г and turn on switch B_1. Use rheostat R_2 to obtain 27 V across the generator shunt winding. Control the current by voltmeter V_2.

Turn on switch B_3 and gradually increasing voltage by potentiometer R_1 determine the relay pickup current by milliammeter mA, then smoothly decrease voltage to determine the relay dropout current. Simultaneously, pickup and dropout currents can be checked by voltmeter V_1. The relay on-off positions are indicated by warning lamps $Л_1$ and $Л_2$. The pickup current should be maximum 90 mA and the dropout current minimum 25 mA.

After checking the relay pickup and dropout currents check the electric strength of the insulation. For this purpose apply 375 V from an A.C., 50 c.p.s., power source to the frame and current-carrying parts; maintain this voltage for one minute at each pair of points.

The results are satisfactory if during the test the insulation and coverings are not punctured.

Note: When checking the electric strength of the insulation, gradually increase voltage to the indicated value, maintain it at this level for one minute and then decrease it to 1/3 of its value, i.e. to 120 V, and cut it off.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

PPT-40 Reversing and Braking Relay

Thoroughly examine the PPT-40 relay removed from the control unit. Prior to examination blow off the relay with compressed air to remove dust and soot caused by the burning of the contacts. Then examine the relay making sure that:

(1) Plastic parts have no cracks or spalling.

(2) Metal parts are not affected by corrosion.

(3) Threaded parts have no stripped-off thread.

(4) Joints are reliably locked.

(5) Winding is undamaged and the joints are reliably soldered.

(6) The moving system of both PT-40 relays does not jam, for which purpose push the lever with a finger; while doing so check operation of the break-make contact.

(7) The contacts and contact strips are in good condition and their material is intact and without carbon deposit.

After external examination check the insulation resistance and the resistance of the relay windings.

Checking the Insulation Resistance

Use a 500-V megger to check the insulation resistance of the current-carrying parts relative to the PT-40 relay frame: place one prod of the megger onto the frame and connect the other consecutively to control terminals 1, 2, 3 and 4 and as well as to power current-carrying terminals 5, 7, 8 and 9 (See Fig. 39). When cold, the insulation resistance of the relay should be minimum 10 megohms. If the insulation resistance is below this figure, check it again after operation (with the relay hot). If the insulation resistance of a heated relay is not below 1 megohm the relay is fit for further operation.

Checking Resistance of the Windings

Check the resistance of the PT-40 relay windings with a testor (TT-1 or TT-2) or any other device. Connect the tester prods to terminals 10 and 11 of the PT-40 relay panel. Resistance should be within 100-120 ohms at an ambient temperature of 20°C. If the winding resistance is above or below 110±10 ohms replace the winding. The new winding is borrowed from the Spare Parts, Tools and Accessories set if it is available, otherwise use the windings from other PT-40 relays that have been received for repair.

If the winding resistance complies with the requirements, check the electric parameters of the cold and hot relay (use the method outlined below). Simultaneously, reveal the cause of the relay trouble.

If the relay is in good repair but its contacts are dirty, remove the dirt with clean writing paper or a smooth cotton cloth soaked in alcohol or dehydrated gasoline.

To provide access to the inner contacts of the PT-40 relay turn out two pairs of screws 20 (See Fig.40) and carefully lifting the relay move it aside from panel 26. This will ensure free access to the contacts and contact strips.

If during fault-finding or tests a trouble is revealed which cannot be remedied without disassembly, disassemble the relay and correct the malfunction.

Disassembly of the PPT-40 Relay

Depending on the nature of the trouble the relay can be disassembled completely or partially.

Disassemble the relay in the following sequence (See Fig.40):

1. Remove two PT-40 relays. Turn out two screws 20 with a screw-driver and pull them out together with the spring

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

washers. Carefully lift the PT-40 relay, unsolder two leads of the PT-40 relay winding from terminals 10 and 11 of terminal block 26 with a small soldering bit and detach the PT-40 relay.

2. Remove lever 5. Release safety washer 7 and raising the lever pull it from axle 6; then take the helical spring off the axle. Turn out screws 3 and nuts 4 from the threaded holes in lever 5.

3. Remove lever 8. Release safety washer 9, take off insulating washer 10 and the helical spring holding lever 8. Compress spring 13 and remove lever 8 from the axle together with spring 13 and washers 12 and 14.

4. Remove terminal block 31. Unsolder the wires from terminals 10 and 12 of left-hand panel 26 and terminals 11 and 13 of right-hand panel 26. Turn out three screws 1 and detach block 31 from panel 28 pulling the wires through the hole in panel 28. Unsolder the wires from the lugs beaded together with terminals 19.

5. Turn out two special screws 21 to detach stand 23 from the panel.

6. Turn out two special screws 21 from the other side of panel 26 and one screw 15 fastening panel 22 of the break-make contact, unsolder the joints of the bus-bars and detach the panels. Check the separate parts of the PPT-40 relay disassembled in this manner for faults and replace them in the repair shops. Stripping the relay units into separate parts makes it possible to utilize those in good repair to the best advantage.

Disassembly of the PT-40 Relay

The PT-40 relay can be disassembled into three main components: electromagnet, moving system and auxiliary parts (See Fig.44). In their turn, these three components can be

stripped into smaller units and parts. Depending on the nature of the trouble the relay can be disassembled completely or partially.

Disassemble the relay in the following sequence:

1. Carefully straighten the centre-punched sections of guard 27 from the side of lever 6 and remove it from the relay using the pliers for the purpose. After this, straighten finally the centre-punched sections on the guard guides.

2. Carefully remove return springs 30 from lever 6 and stand 4.

3. Cut with pliers and remove lock pins 25 fastening lever 6 to the steel support and lever 17 to stand 4.

4. Turn out two screws 2 and remove support 3 together with gaskets 19 placed under the support when required. After this, remove the entire moving system, pulling out core 18 from sleeve 16.

5. Carefully release spring locks 8 of carriage 7, remove levers 6 and 17, with core 18 still hinge-jointed to lever 17.

6. Detach both halves of the carriage and remove the contact strips, insulating washers and springs.

7. Straighten the bent ends of strips 1 and pull them out of housing 24 after which remove stand 28 together with the pole, stand 4 and coil 20 from the housing.

After this check separate parts for troubles and replace the faulty ones.

Repair of Units and Parts

Thoroughly remove dust and dirt from the disassembled units.

Clean with a soft hair brush dipped in pure gasoline and wipe the body with a clean cloth. When cleaning, keep

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

gasoline off the winding since it may destroy the coil insulation.

After cleaning check the parts for faults and subject the coil to an electric test. If during the fault-finding burrs are detected on the internal surface of the PT-40 relay sleeve, replace it together with the windings. If a winding is broken or short-circuited, it should be replaced. To make sure the coil is fit for operation, measure the insulation resistance of the winding relative to the sleeve with a 500-V megger. If the insulation resistance is below 10 megohms, dry the winding in the drying cabinet at 90-100° for 10-14 hours. If after this the insulation resistance is not restored replace the winding.

Remove corrosion detected on the frame, stands, pole, levers or other steel parts. For this purpose clean the place affected by corrosion with No. 200 sand-paper and polish it with ГОИ paste. Wash the polished surface with gasoline, wipe it with a dry cloth, dry it in the open for 10-30 minutes and then in a drying cabinet at 90-100°C for 3-5 hours.

After drying, coat the places cleaned of corrosion with colourless varnish and dry them in the open during one hour.

The plastic carriage, the contact and terminal panels should be free from cracks, chipping and warping. Carefully remove soot and dirt (the former appears due to the sparking of the contacts) as they mix together and form current-carrying bridges which may bring about puncture of the insulation between the contact strips and the stands. Replace cracked and warped carriage and panels.

Coat the worn panels with colourless varnish and dry them in the open during one hour.

If the contacts have traces of burning with spattered copper, replace them together with the panel. If the burnt area spreads over not less than 60% of the contact surface but has no high spots and craters, wash the contacts in alcohol and

wipe them with a piece of clean shammy. Small holding parts with intact thread washed in gasoline and dried in the open for 30 min. can be used during assembly while the parts with stripped-off thread and dents (especially washers) should be replaced.

The galvanic coating of the holding parts and bus-bars can be restored; brass parts should be tinned and steel parts covered with cadmium or zinc coating. The coat of tin should be 4-6 microns and of cadmium and zinc - 3-5 microns thick. Cadmium-plated or zinc-coated steel parts should be subjected to chrome passivation which promotes considerably the anti-corrosion properties.

After the relay has been repaired and its faulty parts replaced, assemble the relay.

The assembly is the reverse of disassembly.

Assembly of the PT-40 Relay (Fig. 44)

Assembly of lever 17

1. Insert two axles and the shaped nut into one half of lever 17 and fit on the other half.

2. Flatten the axle in the middle section of the lever; the permissible parallel misalignment of the plane of one half of the lever relative to the other should not exceed 0.3 mm.

The shaped nut should freely rotate in the holes of the levers.

Assembly of housing 24 with coil 20 and stand 4

1. Insert coil 20 into housing 24 so that the coil leads enter the housing slots.

2. Insert two strips 1 into the housing slots.

3. Press stand 4 into housing 24 making sure that the end of strips 1 enter the windows of stand 4.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Assembly of housing 24 with stand 28 and bending the tops of strips 1.

1. Press housing 24 onto stand 28 as far as it will go.

2. Use a feeler gauge to check the gap between stands 28 and body 24 which should be maximum 0.15 mm. Shake the assembly to make sure the coil has no play.

3. Locate the ends of strips 1 uniformly relative to the stands and bend them over the washer.

4. Using a hammer and a textolite mandrel, straighten [illegible] on the stand on the plate.

Assembly of carriage 7 with the levers

1. Carefully remove dust with a hair brush from all parts of the assembly.

2. Wash contact strips 10 and 13 in alcohol and fit them into one half of carriage 7..

3. Insert two washers 12 into the ends of spring 11 and fit the spring into the carriage seat.

4. Insert two washers 15 into the ends of two springs 14 and fit the springs into the carriage seat.

5. Insert washers between the ends of springs 14 and strip 13.

6. Insert the axles of levers 6 and 17 into the slots of carriage 7 and fit on the other half of the carriage aligning the slots and straightening the parts resting against the upper half of the carriage.

7. Place springs 8 onto both ends of the strips.

8. Check manually for jamming of strips 10 and 13 as they shift in the carriages.

9. Turn core 18 into the nut of lever 17 all the way in.

Assembly of the Housing with the Carriage and Lever

1. Dip a tampon in alcohol and wipe the interior surface of sleeve 16.

2. Insert core 13 into the sleeve and fit in levers 6 and 17 taking care to align the holes in the stands. Insert the pins oiled with OKB 122-14 grease.

3. Flatten the ends of the lock pins providing for an axial play not less than 0.5 mm and uniform protrusion of the lockpin ends.

4. Check whether the lock pin ends are flattened sufficiently from both sides by sinking them into the holes.

5. Fit in rest 3 and secure it by screws 2 with a spring washer ensuring at least a 0.3-mm play between the rest and the upper end of the core nut.

Fitting Two Springs

1. Fit in two return springs 30.

If the spring contacts the housing, bend the ends of lever 6.

Assembly of the PPT-40 Relay (See Fig.40)

Assembly of the Relay Unit and Wiring

1. Fit two panels 26 and attach stand 23 on the other side with screws 21. Attach strip 27 with the same screws.

Fix panel 22 of the break-make contact between panels 26.

2. Turn the assembled unit with the contact stands marked with figures upwards and arrange the wiring according to the circuit diagram (See Fig.39).

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

3. Coat the soldered joints of the leads with AB4-M/B varnish mixed with a dye and paint the soldered joints of the bus-bars with nitroenamel 1201.

Mounting the Lever of the Break-Make Contact on the Relay Unit

1. Wash the contacts of lever 8 and the contacts of panel 22 with dehydrated gasoline.

2. Assemble spring 13 with thrust washer 14, pressing washer 12 and lever 8.

Mount the assembled unit on panel 22 so that lever 8 is fitted onto the panel axle, then place a spring and an insulating washer onto the axle and insert lock washer 9 into its slot.

3. Turn nut 4 onto each of the two screws 3 and turn the screws into the holes of lever 5.

4. Fit the spring and lever 5 onto axle 6 so that the end of lever 8 enters the slot in lever 5. Make sure the levers change-over smoothly without jamming. Fix lock washer 7 on top of lever 5.

Mounting Two PT-40 Relays on the Relay Unit

1. Mount the PT-40 relay on the panel of the relay unit.

(a) Check and adjust the core travel to 3±0.25 mm. Adjust with shims 19 (See Fig.44) placed under rest 3. Maintain a maximum distance of 1.2 mm. between the core end and the axle of the lock pin fastening lever 17 on stand 4.

(b) Check and adjust the contact pressure travel which should be minimum 0.5 mm. Adjust by turning off core 18 and bending the contact bus-bars on the panel.

The procedure should be carried out as follows:

Adjust at the expense of the core movement the pressure travel of the main contacts, which should be the same for each contact. Check the pressure travel of the auxiliary contacts.

If the pressure travel of one of these contacts is below 0.5 mm move the core to increase it.

Move the core until the pressure travel of one of the main contacts is not less than 0.5 mm.

If, nevertheless, the pressure travel on the auxiliary bus-bars is less than 0.5 mm, make final adjustment of the pressure travel by bending the contact bus-bars as little as possible.

2. Apply voltage to the relay windings to check and adjust the relay pickup voltage within 14-14.5 V. Adjust by uniformly expanding the middle coils of springs 30.

3. Fit guard 27 on the relay housing and centre-punch it in four points.

To prevent springs 30 from contacting the guard and housing, bend the top of lever 6.

4. Attach the lugs of the PT-40 relay stands to the panel by screws 20 (See Fig.40) with spring washers. To mount the PT-40 relay on panel 26 properly and obtain the alignment of the axles of the contact bus-bars and strips, place washers under the lugs of the stands.

The axles of the moving contact strips should not shift relative to the fixed ones more than 0.8 mm.

5. Solder the output leads of the winding to the bus-bars of panel 26. When soldering bend the coil output leads in a loop, 4-5 mm in dia.

Wipe the soldered joints with a cloth soaked in alcohol and paint with AB4-M/B varnish mixed with dye.

Adjusting the PPT-40 Relay and Checking Its Operation

1. Use screws 3 of the switch to adjust the pickup voltage of each PT-40 relay making sure it does not

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

exceed 15.5 V. The metal parts of lever 5 (switch) may be slightly bent. The relay should operate promptly and the core should reach the end.

2. Tighten nuts 4 securing adjusting screws 3 of the switch and draw a neutral line with enamel 1201 on the nuts and the switch lever.

Flood the screws of both cores with AB4-A/B varnish mixed with dye.

3. Wash all contacts with dehydrated gasoline, especially the auxiliary (inner) contacts.

Checking the Assembled Relay

1. Make sure that the unit is assembled in conformity with the drawing. See to it that the parts are not damaged, the soldering is of high quality and accurate and the joints are coated with slightly coloured varnish AB4-A/B.

Check to see that all screws are thoroughly tightened and the switch shifts freely without jamming.

2. Check, by external examination,, the axles of the moving contact strips and the axles of the contact stands for alignment. The axles of the moving contact strips should not shift relative to the fixed ones more than 0.8 mm.

3. Check the gaps between the contacts. In a deenergised relay the gap between the contact strip plane and the bus-bar should be not more than 0.3 mm.

4. Check the insulation resistance. The insulation resistance of the current-carrying parts relative to the frame should be minimum 20 megohms.

Testing

Prior to testing inspect the relay externally and check the standard of assembly, finish and markings.

Checking the Relay Operation and Ratings

Measure the pickup voltage of a cold relay. For this purpose cut the relay into the control desk circuit (Fig.50) and start the D.C. generators. The relay windings can be supplied from any 30-V D.C. generator providing a load up to 5 A.

For supplying power to the relay power circuit a D.C. source ensuring a load up to 50 A with 20-30 V at idle run is required.

Use rheostat R_1 to reduce voltage to 5-10 V, set switch $П_1$ in position 1 and switches $П_2$, $П_3$ and $П_4$ in position 2. Gradually increase voltage and watch the readings of voltmeter V; record the pickup voltage. The switching-on of the relay is indicated by flashing-on of warning lamp Л. The relay pickup voltage should be maximum 16 V. Set switch $П_1$ in position 2 and measure the pickup voltage of the other relay in the same manner.

After measuring the pickup voltage, turn off switch $П_1$, set switches $П_2$, $П_3$ and $П_4$ in position 1 and use rheostat R_1 to obtain 27 V on voltmeter V. Then check the relay operation during starting, reversing and braking of the 300-400 watt series-wound D.C. electric motor with 40 A across the main contacts obtained by means of rheostats R_3 and R_4. In all, make 40 engagements for each direction by switch $П_1$. Then operate the relay to heat-run it for 40 minutes for each winding at 27 V and 40 A of resistive load across the contacts. During the operation for heating set switches $П_2$ and $П_3$ in position 2 and set a current of 40 A (by ammeter A_2) by means of rheostat R_2.

The test results are considered satisfactory if the relay operates promptly and the core goes right home.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

exceed 15,5 V. The metal parts of lever 5 (switch) may be slightly bent. The relay should operate promptly and the core should reach the end.

2. Tighten nuts 4 securing adjusting screws 3 of the switch and draw a neutral line with enamel 1201 on the nuts and the switch lever.

Flood the screws of both cores with AB4-A/B varnish mixed with dye.

3. Wash all contacts with dehydrated gasoline, especially the auxiliary (inner) contacts.

Checking the Assembled Relay

1. Make sure that the unit is assembled in conformity with the drawing. See to it that the parts are not damaged, the soldering is of high quality and accurate and the joints are coated with slightly coloured varnish AB4-A/B.

Check to see that all screws are thoroughly tightened and the switch shifts freely without jamming.

2. Check, by external examination,, the axles of the moving contact strips and the axles of the contact stands for alignment. The axles of the moving contact strips should not shift relative to the fixed ones more than 0,8 mm.

3. Check the gaps between the contacts. In a deenergised relay the gap between the contact strip plane and the bus-bar should be not more than 0,3 mm.

4. Check the insulation resistance. The insulation resistance of the current-carrying parts relative to the frame should be minimum 20 megohms.

Testing

Prior to testing inspect the relay externally and check the standard of assembly, finish and markings.

Checking the Relay Operation and Ratings

Measure the pickup voltage of a cold relay. For this purpose cut the relay into the control desk circuit (Fig.50) and start the D.C. generators. The relay windings can be supplied from any 30-V D.C. generator providing a load up to 5 A.

For supplying power to the relay power circuit a D.C. source ensuring a load up to 50 A with 20-30 V at idle run is required.

Use rheostat R_1 to reduce voltage to 5-10 V, set switch $П_I$ in position 1 and switches $П_2$, $П_3$ and $П_4$ in position 2. Gradually increase voltage and watch the readings of voltmeter V; record the pickup voltage. The switching-on of the relay is indicated by flashing-on of warning lamp Л. The relay pickup voltage should be maximum 16 V. Set switch $П_I$ in position 2 and measure the pickup voltage of the other relay in the same manner.

After measuring the pickup voltage, turn off switch $П_I$, set switches $П_2$, $П_3$ and $П_4$ in position 1 and use rheostat R_1 to obtain 27 V on voltmeter V. Then check the relay operation during starting, reversing and braking of the 300-400 watt series-wound D.C. electric motor with 40 A across the main contacts obtained by means of rheostats R_3 and R_4. In all, make 40 engagements for each direction by switch $П_I$. Then operate the relay to heat-run it for 40 minutes for each winding at 27 V and 40 A of resistive load across the contacts. During the operation for heating set switches $П_2$ and $П_3$ in position 2 and set a current of 40 A (by ammeter A_2) by means of rheostat R_2.

The test results are considered satisfactory if the relay operates promptly and the core goes right home.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Checking the Insulation Resistance

The resistance of the heated insulation is tested with a 500-V megger, the voltage being applied between the current-carrying parts and the housing.

The test results are considered satisfactory, if the insulation resistance is not below 1 megohm.

Checking the Electric Strength of Insulation

Check the electric strength of the insulation right after the relay heat run. For this purpose apply 375 V from an A.C. source of 50 c.p.s. between the current carrying parts and the housing. Maintain this voltage for one minute.

The test results are considered satisfactory, if during the test the insulation and coverings are not punctured.

Note. When testing the insulation for electric strength gradually increase voltage to the indicated value, maintain it at this level for one minute and then reduce it to 1/3 of its value (120-130 V) and cut it off.

ASSEMBLY OF THE APV-2A CONTROL UNIT

After the separate components making up the APV-2A control unit have been repaired and tested proceed to assemble the unit.

The completely stripped control unit is assembled in the following sequence (See Fig.16):

Operation 1. Mounting two PC-3 relays 7.

1. Solder the wires to the terminals of two PC-3 relays in conformity with the wiring diagram of the APV-2A control unit (See Fig.23). Cut off excess lengths of wires to size to fit them in correctly according to the diagram.

2. Fit the vinyl chloride sleeves onto the soldered joints.

3. Mount two PC-3 relays on panel 21 and secure them with screws 6. Place spring washers under the screw heads.

Operation 2. Mounting the adjustable resistor ПЭВ-25Х-510 ohms 3.

1. Solder the wires to the terminals of the adjustable resistor in conformity with the wiring diagram. Cut off extra lengths of wires at assembly.

2. Fit vinyl chloride sleeves onto the soldered joints.

3. Insert bushings 4 into the adjustable resistor from both sides.

4. Mount the adjustable resistor on panel 21 and secure it with screw 5. Place a spring washer under the screw head.

Operation 3. Mounting the ABC-13-53 selenium rectifier 8.

1. Mount the selenium rectifier on panel 21 and secure it with a nut. Place a spring washer under the nut.

Operation 4. Mounting panel 2.

1. Mount panel 2 on panel 21 and secure it with two screws 1. Place spring and ordinary washers under the screw heads. Place the ordinary washers from the side of panel 2.

2. Solder the wires to the terminals of panel 2 in conformity with the wiring diagram and carefully fit them in.

3. Solder resistor R_4 to the terminals of panel 2 in conformity with the wiring diagram.

Operation 5. Mounting the capacitor МБГЧ-3-160-2х0,5 10.

1. Mount the capacitor on panel 21 and secure it with two screws 9. Place spring washers under the screw heads.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Operation 6. Mounting the block of the PKO polarized relay 11.

1. Solder the wires to the terminals of the PKO polarized relay block in conformity with the wiring diagram. Cut off excess lengths of wires.

2. Fit vinyl chloride sleeves onto the soldered joints.

3. Fix the block of the PKO polarized relay onto washer 42 with the flat towards the stand of panel 21.

Operation 7. Mounting terminal block 40.

1. Solder wires to the terminals of terminal block 40 from one side in conformity with the wiring diagram.

Note. Before soldering pass the wires through-shaped nut 41.

2. Fit vinyl chloride sleeves onto the soldered joints.

3. Fix panel 21 with all units mounted on it on base 16, and check the position of the PC-3 relay relative to the boss in base 16. Make sure that the clearance between the PC-3 relay and base 16 boss is minimum 0.2 mm. If the clearance is smaller, file the boss of base 16 near the PC-3 relay a little and coat the filed-off places with AB-4Д/B colourless varnish.

4. Fit packing ring 39 into the recess in base 16.

5. Install terminal block 40 into the recess in base 16 and clamp it tightly with shaped nut 41.

Note. After completion of operation 7 solder the rest of the wires to the vacant terminals of respective units in conformity with the wiring diagram. Fit vinyl chloride sleeves onto the soldered joints.

Operation 8. Mounting the reversing and braking relay PPT-40 27.

1. Collect the wires leading to the PPT-40 relay in a bunch and protect it with vinyl chloride sleeve 23.

2. Connect the wires to the PPT-40 relay after cutting off excess lengths to size and tinning the ends.

3. Mount the PPT-40 relay on panel 21 and secure it with four screws 26. Place spring washers under the screw heads.

4. Secure the bunched conductor leading to the PPT-40 relay on panel 21 with clamp 24 fastened with screw 25. Place a spring washer under the screw head.

Operation 9. Mounting the PKO polarized relay 43.

1. Place the PKO relay 43 on block 11.

2. Fit bracket 20 onto the PKO relay.

3. Secure bracket 20 on panel 21 with two screws 22 and nuts. Place spring washers under the nuts.

Note: 1. When mounting bracket 20 see that washer 42 is bent to 0.5-0.8 mm of its original thickness by placing ordinary washers under the bracket lugs.

2. Use coloured conductors, grade МГВБ 0.5 and 1.5 mm^2 in cross-section for the internal wiring of the control unit. Joint the wires with solder ПОС-40.

Operation 10. Mounting the small-size potentiometric transmitters МРД-106 49 and МРД-126 53.

1. Fit the small-size potentiometric transmitter МРД-106 49 into the recess in base 16.

2. Fit the small-size potentiometric transmitter МРД-126 53 into the other recess in base 16.

3. Place two washers 36 under each of the two vacant lugs of the potentiometric transmitter МРД-126.

4. Secure the potentiometric transmitters with five screws 37. Place spring washers under the screw heads.

5. Close the potentiometric transmitters with cover 30.

6. Fasten cover 30 to base 16 with three screws 52. Place spring washers under the screw heads.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

7. Solder the wires running from the potentiometric transmitters to the terminals of terminal block 40 in conformity with the wiring diagram.

8. Fit vinyl chloride sleeves onto the soldered joints.

Operation 11. Mounting the block of the plug connector ШР32ШК12ОП 3I.

2. Solder grade БПВЛ wires with a cross-section of 0.5 and 1.5 mm^2 to the terminals of block 40 in conformity with the wiring diagram.

[illegible] Fit vinyl chloride sleeves onto the soldered joints.

3. Collect the wires into a bunch and place wire mesh 35 onto it.

4. Fix cap 38 and secure it with two screws 47. Place spring washers under the screw heads.

5. Fit clamp 55 on the bunched conductor encased in the wire mesh and the wires from the small-size potentiometric transmitters and secure it with screws 54. Place spring washers under the screw heads.

6. Solder the wires running from terminal block 40 to the pins of plug connector 31 in conformity with the wiring diagram after passing union 32 and the terminal nut of the plug connector block through them.

7. Fit vinyl chloride sleeves onto the soldered joints.

8. Place wire mesh 35 onto union 32. Fit a ring onto the wire mesh and collar 34 onto the ring.

9. Clamp collar 34 with screw 33. Place a spring washer under the screw head.

10. Screw the terminal nut of the plug connector block onto the block.

Note. Adjust the control unit arranged in this manner together with the АРУ-2А servomechanism. During adjustment select proper resistors R_1, R_2, R_3, R_5, R_6 and solder them to the respective terminals of panel 2 as shown in the wiring diagram.

After adjustment finish up the control unit.

Operation 12. Mounting panel 21.

1. Fix panel 21 with all units mounted on it on base 16 and secure it with four screws 28. Place spring washers under the screw heads.

2. Check the clearance between the boss in base 16 and the РС-3 relay.

3. Thoroughly blow off the control unit with dry compressed air.

Operation 13. Mounting cover 13.

1. Place cover 13 on assembled panel 21 aligning the holes in the cover with the pins in base 16.

Note. Adjust cover 13 so that the grooves milled on the internal sides are located opposite to adjustable resistor 3, resistors 12 and polarized relay 43.

2. Fasten the cover to base 16 with eight screws 14. Place spring washers under the screw heads.

3. Fasten the cover to base 16 additionally with five screws 19 by means of nuts 29 and 46. Place spring washers under the nuts.

Operation 14. Mounting plate 17 with dampers 44.

1. Bind one screw 52 and screw 19 with wire 51 and attach seal 50.

2. Place plate 17 with dampers 44 on base 16 and secure it with eight screws 45. Place spring washers under the screw heads.

After testing the control unit connect the block of plug connector 31 with the insert.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

ADJUSTING THE AUTOMATIC SYSTEM

The automatic system is adjusted on a test stand whose electric circuit and the air system are represented in Figs 51 and 52.

Before adjustment set all switches in OFF position, deenergize the power sources and shut the cocks of the pneumatic system.

The purpose of adjustment is to ensure the fulfilment of the adjustment law as shown in Fig.8, with dynamic and static pressures built up in the pneumatic system.

The adjustment law is valid for the international standard atmosphere, i.e. for a pressure of 760 mm Hg and zero altitude above sea level.

If the atmospheric pressure of the day differs from the international standard atmosphere an appropriate correction should be introduced into the altitude indicator.

The method of checking and introducing correction into the altitude indicator is outlined below.

To adjust the automatic system, proceed as follows:

Preliminary Operations

(a) Before adjusting and testing the automatic system check the pointers of the speed and altitude indicators for proper setting and introduce necessary corrections.

The pointers of the speed indicator should be at the scale zero. The misalignment of the speed indicator pointers should not go beyond the permissible error limit.

The mercury manometer should be filled with mercury to zero.

Check the readings of the altitude indicator pointers. Determine in advance the atmospheric pressure of the day by the control barometer.

To introduce correction into the altitude indicator, set the altitude indicator for a pressure of 760 mm Hg on the bottom scale. Make sure the "smaller" pointer of the altitude indicator reads zero and the "larger" pointer indicates an altitude corresponding to the barometric pressure of the day (with deviations within the permissible error limit).

The readings of the "larger" pointer of the altitude indicator at various atmospheric pressures of the day are given in the Table below:

Barometric pressure, mm Hg	Deflection of altitude indicator, m.	Barometric pressure, mm Hg	Deflection of altitude indicator, m.
781.89	-240	753.01	100
780.04	-220	749.25	120
778.20	-200	747.46	140
776.36	-180	745.69	160
774.53	-160	743.92	180
772.71	-140	742.14	200
770.88	-120	740.38	220
769.06	-100	738.61	240
767.24	-80	736.85	260
765.43	-60	735.10	280
763.61	-40	733.34	300
761.80	-20	731.59	320
760.00	0	729.85	340
758.20	20	728.11	360
756.40	40	728.37	380
752.82	80		

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Example. At a barometric pressure of the day equalling 740.38 mm Hg the "larger" pointer of the altitude indicator should show 220 m. counting from the scale zero rightwards.

(b) Mount the servomechanism of the automatic system on the test device (See Fig.74) and secure it with two lugs and wing nuts. Fix and secure the pointer on the ball bearing of the servomechanism rod.

(c) Connect the control unit and the servomechanism to the test desk by means of plug connectors. Attach also the position indicator with two clamps.

To provide for a more convenient adjustment and replacement of the resistors it is advisable, before connecting the control unit to the desk, to attach short lengths of insulated wire (150-200 mm long), to the contact segments of panel 2 with the help of a small soldering bit (See Fig.16), and then solder to these wires the following type BC-0.5 resistors:

R_1 - 300 ohms, R_2 - 390-430 ohms, R_3 - 11-13 kilohms, R_5 - 9-10 kilohms, R_6 - 5.1-8 kilohms.

The constant 100-ohm resistor R_4 is soldered to the respective contact segments on the panel in conformity with the wiring diagram (See Fig.23).

In order not to confuse the wires use conductors of different colour, for example: the wires from the contact segments of the panel for resistor R_1 are red, for resistor R_2 - green, etc.

(d) Connect the air system hoses to the unions of the transmitters MPA-106 and MPA-126 of the control unit: the dynamic pressure hose to union Д and the static pressure hose to union C_1.

WARNING. When connecting the static and dynamic pressure hoses of the air system take care not to confuse them since this may cause breakage of the transmitters.

(e) Switch on the electric circuit and air system power supply by the magnetic starters.

(f) Turn on switch B_1 and obtain 28±0.5 V on voltmeter V_1 by rheostat R.

(g) Turn on switches B_2, B_3 and B_4 and set switch П in position 1 (manual control).

Checking the Total Stroke of the Servomechanism Rod

The total stroke of the servo rod is checked with push switches K_1 and K_2. Shift the servomechanism rod into the extreme - retracted - position (smaller arm) by jogging push switch K_1. Watch warning lamp $Л_2$ to flash on.

With the rod retracted note on the rule the initial position of the pointer. Then jogging push switch K_2 shift the rod of the servomechanism to the other extreme (extended) position (bigger arm) and watch warning lamp $Л_1$ to flash on. Note the total stroke of the rod with the help of the rule. The total stroke of the rod from one extreme position to the other should be within 42-48 mm.

After checking the total stroke set switch П in position 2 (automatic control).

Adjusting the Automatic System for Dynamic (Impact) Pressure

Before adjustment obtain 10 V on voltmeter V_2 with the aid of resistor ПЭВ-25Х-510 ohms.

Use cock K_1 to increase gradually excess pressure in the dynamic cavity of the transmitter MPA-106 (with atmospheric pressure in the static cavity of the transmitters MPA-106 and MPA-126).

The rod of the servomechanism should begin to move from the "bigger" to the "smaller" arm at a pressure of 85-92 mm Hg and stop at the "smaller" arm at 330-350 mm Hg. In this

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

case the "smaller" arm should be within 50-53 mm. As the automatic system begins to operate, warning lamp $Л_1$ goes out; at the end of the rod stroke warning lamp $Л_2$ flashes on.

Decrease excess pressure in the dynamic cavity of the transmitter МРД-106 and check the beginning of the automatic system operation from the "smaller" to the "bigger" arm, the end of operation at the "bigger" arm and its size.

The automatic system should begin to operate for shift from the "smaller" arm at a pressure of 330-350 mm Hg and stop at the "bigger" arm at minimum 67 mm Hg; at the "bigger" arm the rod should protrude by 95-98 mm.

The adjustment is carried out at the expense of the tolerance margin for the "smaller" and "bigger" arms by shifting the feedback potentiometer with the help of the adjusting axle (See Ref. No. 2 in Fig.61).

After adjusting the operation for dynamic pressure check the accuracy of the automatic system performance, which is characterized by the number of engagements of the servomechanism electric motor.

When the excess pressure in the dynamic cavity of the МРД-106 transmitter is gradually increased from 35-92 to 330-350 mm Hg in 60-90 sec., the number of engagements of the servomechanism electric motor should be minimum 20.

The number of engagements of the electric motor during a gradual decrease of excess pressure in the dynamic cavity of the transmitter МРД-106 is the same (minimum 20).

Adjust by changing voltage across the resistor ПЭВ-25К-510 ohms within the tolerance margin, i.e. within 8-11 V and by selecting resistors R_3, R_5 and R_6 in conformity with the Table below.

If the number of engagements of the servomechanism electric motor is below 20, increase voltage across resistor ПЭВ-25К-510 ohms within the tolerance margin, i.e.

within 8-11 V and raise resistance of R_3, R_5 and R_6 in the positive feedback circuit according to the following Table:

Table

Descriptions in the diagram (Fig.23)	Type of resistor	Values of resistance necessary for adjusting the automatic system control unit
R_1	ВС-0,5	200, 220, 240, 270, 300 ohms
R_2	ВС-0,5	390, 430, 470, 510, 560, 620 ohms
R_3	ВС-0,5	5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 10, 11, 12, 13, 15, 16, 18 kilohms
R_4	ВС-0,5	100 ohms
R_5	ВС-0,5	5.1, 5.6, 6.2, 6.8, 7.5, 8.2, 9.1, 10, 11, 12, 13, 15, 16, 18 kilohms
R_6	ВС-0,5	5.1, 5.5, 6.2, 6.8, 7.5, 8.2, 9.1, 10, 11, 12, 13, 15, 16, 18 kilohms

Note: During adjustment use can be made of resistors with intermediate values.

Adjusting Altitude Correction

Set the position indicator pointer at division 5 (altitude scale) by shifting the adjusting axle of the mismatch transmitter position indicator potentiometer (See Ref. No. 21 in Fig. 61).

Operate cock K_1 to gradually create an excess pressure of 330 - 350 mm Hg in the dynamic cavity of the МРД-106

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

transmitter; in this case the rod of the servomechanism is retracted and warning lamp $Л_2$ burns.

Operate cock K_2 to gradually create a rarefaction in the static cavity of the МРД-126 transmitter.

The rod should begin to shift from the "smaller" to the "bigger" arm at a rarefaction corresponding to an altitude of 4800 - 5200 m. and cease its travel at the "bigger" arm at a rarefaction corresponding to an altitude of 9800 - 10,200 m. At the end of the automatic system operation for altitude warning lamp $Л_1$ should flash on.

The beginning of the automatic system operation for altitude is adjusted by changing the value of resistor R_1 in conformity with the Table given above.

The end of the automatic system operation for altitude is adjusted by changing the value of resistor R_2 according to the Table or at the expense of the tolerance margin for the beginning and end of the automatic system altitude operation. After adjustment for altitude, check the accuracy of the automatic system operation, which will be characterized by the number of engagements of the servomechanism electric motor. The number should be within 15-33 when rarefaction in the static cavity of the МРД-126 transmitter, corresponding to an altitude from 4800-5200 to 9800-10,200 m., is gradually changed in 60-90 sec.

After the automatic system has been adjusted fill the adjusting axles of the feedback and position indicator potentiometers with БФ-2 glue, perform finishing jobs on the control unit and the servomechanism (See Section "Assembly of the Control Unit") and proceed to test the entire set (See Section "Testing the Automatic System").

Note. During adjustment fit-up jobs on the control unit shown by the dashed line in the diagram (See Fig.23) are permitted.

TESTING THE АРУ-2А AUTOMATIC SYSTEM

The АРУ-2А automatic system is tested on a special installation, whose circuit is shown in Fig.51. The air system of the automatic system is shown in Fig.52.

For the sake of convenience in adjustment and testing, the electric circuit and the air system of the installation are mounted on a common desk.

The installation circuit makes it possible to check the performance of all elements of the automatic system in operation and ensures automatic switching on and off of the system servomechanism depending on the change in dynamic and static pressures, i.e. speed and altitude of flight.

This circuit almost entirely simulates the operation of the automatic system on aircraft except for the fact that no load is applied to the servomechanism rod and artificial feel mechanism.

The installation set comprises the following main parts:

(a) electric circuit;

(b) air system;

(c) electric circuit and air system supply units.

Electric Circuit

The electric circuit (See Fig.51) incorporates the following elements:

(a) Supply unit providing power for the desk and actuated by type П-222 magnetic starter.

(b) Storage battery with a minimum of 28 A/hr intended to maintain constant voltage in the process of starting of the servomechanism electric motor.

The installation electric circuit should be never used without a storage battery which serves to "smooth out" instantaneous drops in the mains voltage when the electric motor of the automatic system servomechanism is being started.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

If the storage battery is not available, even a high-power D.C. generator used for testing the automatic system will not eliminate frequent makes and breaks of the PPT-40 relay (the so-called jingling of the contacts) which will persist despite adjustment. This phenomenon has a very harmful effect on the PPT-40 relay contacts for it may cause their sticking.

(c) Rheostat R_1, 160 ohms, 1.5 A changing voltage across the terminals of the D.C. generator.

(d) Voltmeter V_1, 30 V of 1-1.5 accuracy class (for example, type M1 or M-340) checking the generator voltage.

(e) Voltmeter V_2, 15 V of 1-1.5 accuracy class (for example, type M1 or M-340) checking the supply voltage of the transmitters.

(f) Counter C_4 registering the number of engagements of the automatic system.

(g) Switch B_1 supplying current from the storage battery to the field winding of the D.C. generator.

(h) Switch B_2 connecting the storage battery in parallel with the terminals of the D.C. generator.

(i) Switch B_3 supplying current to the control unit.

(j) Switch B_4 supplying current to switch II, servomechanism, auxiliary relay PE-2 and warning lamps $Л_1$ and $Л_2$ which indicate the position of the servomechanism rod.

Lamp $Л_3$ serves to check the electric connection between the control unit body and the plus of the electric circuit, i.e. the wiring of the control unit.

(k) Switch II actuating the automatic system manually or automatically.

(l) Push switches K_1 and K_2 actuating the servomechanism electric motor for extension or retraction of the rod, i.e. for the bigger or smaller arm.

(m) Two plug connectors МР32ПКI2НМI connecting the control unit and the servomechanism of the automatic system to the installation circuit.

(n) Position indicator.

Besides, the installation electric circuit includes a vacuum pump supply unit, type II-222 magnetic starter and type II-25 D.C. safety fuses.

Air System

The air system (See Fig.52) incorporates the following elements.

(a) Type ВН-494 vacuum pump creating dynamic and static pressure in the air system.

(b) Mercury manometer for 600 mm Hg used to check the automatic system operation for dynamic (impact) pressure.

(c) Type КУС-1200 or КУС-2000 speed indicator. The purpose of the speed indicator is the same as that of the mercury manometer, the readings of the latter being more accurate. If the mercury manometer is not available, the automatic system operation can be checked with the help of a speed indicator if it meets its own technical requirements or conforms to its own description.

(d) Type ВД-17 or ВД-20 altitude indicator used to check the automatic system operation for static pressure, i.e. for altitude.

(e) Compensating tanks, 3-lit. capacity each, intended to accumulate a reserve of air in the air system and protect the latter against air pulsation.

(f) Needle shut-off cocks admitting or stopping an air flow from the vacuum pump into the air system.

(g) Air hoses (rubber or durite) and T-pieces linking all elements of the air system.

Supply Units

1. The supply unit of the electric circuit comprises type A-32-2, 220/380 V, A.C. asynchronous electric motor

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

(power 1.7 kW, speed 2340 r.p.m.) and a type ГСК-1500 D.C. generator.

If these power sources are not available, use can be made of any other D.C. source providing a load up to 50 A and a voltage variation from 24 to 30 V.

Any type of storage battery may be used provided it ensures a minimum capacity of 28 A/hr at 24 V (for example, 12СТ-28).

2. The supply unit of the air system comprises a type A-31-4, 220/380 V, A.C. electric motor (power 0.6 kW, speed 1440 r.p.m.).

If the ВН-461 vacuum pump and the A-31-4 electric motor are not available, use any other vacuum pump ensuring a rarefaction up to 90 mm Hg and a pressure up to 400 mm Hg.

The electric circuit and the air system are mounted on the test desk (except for the supply units, storage battery and vacuum pump located near the test desk). The test desk is a table with a vertical panel at the far end which mounts voltmeters V_1 and V_2, on-off position counter C_4, switches B_1, B_2, B_3, B_4, switch П push switches K_1 and K_2, warning lamps $Л_1$, $Л_2$ and $Л_3$, mercury manometer, КУС-1200 speed indicator, ВД-17 altitude indicator, shut-off cocks and start buttons of the magnetic starters of the supply units.

Arranged on the table are two type ШР32ПКI2НШ plug connectors.

A rheostat for adjusting the voltage of the D.C. generator is attached at the side of the desk.

Mounted on the other side are two compensating tanks, magnetic starters of the supply units and safety fuses in the A.C. and D.C. circuits.

Testing the АКУ-2А Automatic System

Set all switches at OFF, deenergize the power sources and shut the shut-off cocks of the air system.

Then proceed to test the automatic system in the following sequence.

Preliminary Operations

The preliminary operations are the same as outlined in Section "Adjusting the Automatic System".

Checking the Nominal Ratings and Operation of the Automatic System

Check in the following sequence:

(a) Check manually the big and small arms of the automatic system (servomechanism) to the power booster: shift the rod of the servomechanism to the extreme (retracted) position jogging push switch K_1 and watch warning lamp $Л_2$ to flash on.

Check by the rule the size of the smaller arm which should be within 50-53 mm with the help of the pointer secured on the servomechanism rod.

Operate push switch K_2 intermittently to shift the rod of the servomechanism to the extreme (extended) position and watch warning lamp $Л_1$ to flash on. Use the pointer to check with the rule the size of the bigger arm which should be within 95-98 mm.

Check the time required for the servo rod to travel from one extreme position to the other: depress push switch K_1 and use a stopwatch to register the time necessary for the servomechanism rod to shift from one extreme position to the other. The time of travel should not exceed 4 sec.

Check again the time of the rod travel by depressing push switch K_2.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

(b) Check excess pressure in the dynamic cavity of the МРД-106 transmitter with atmospheric pressure in the static cavity of the transmitters МРД-106 and МРД-126 at which the rod of the servomechanism begins to move from the "bigger"to the "smaller"arm and stops at the "smaller" arm.

Besides, check the number of engagements of the servomechanism electric motor and the differential excess pressure in the dynamic cavity of the МРД-106 transmitter with the servomechanism rod moving from any position, i.e. the value of the differential pressure between any subsequent switchings of the electric motor.

For this purpose set switch II in position 2 (automatic control), open cock K_1 and use the mercury manometer or the speed indicator to note the moment the servo rod begins to move to the "smaller" arm.

The rod should begin to shift at a pressure of 85-92 mm Hg.

After starting the electric motor several times warning lamp $Л_1$ goes out.

Then, increasing excess pressure by the mercury manometer or the speed indicator determine its value at the end of the stroke of the servomechanism rod, i.e. the pressure at the "smaller" arm.

Warning lamp $Л_2$ should flash on as the servo rod stops at the "smaller" arm. The motion of the rod should cease at the "smaller" arm at a pressure of 330-350 mm Hg.

Pressure in the dynamic cavity of the МРД-106 transmitter should change gradually during 60-90 sec.

The number of engagements of the МУ-100АП electric motor of the servomechanism at pressure change from 85-92 to 330-350 mm Hg should be at least 20 which is indicated by the counter.

The servomechanism electric motor should be switched on at a differential pressure within 5-15 mm Hg.

(c) Check the beginning of the automatic system (servomechanism) rod shift from the "smaller" to the "bigger" arm at an excess pressure in the dynamic cavity of the МРД-106 transmitter of 330-350 mm Hg and with an atmospheric pressure in the static cavity of the МРД-106 transmitter and a rarefaction in the static cavity of the МРД-126 transmitter corresponding to an altitude of 4700-5300 m.; check also the end of the rod stroke at the "bigger" arm and its size at the end of the altitude stroke.

Besides, check the number of engagements of the servomechanism electric motor and the altitude drop, i.e. the altitude drop between two subsequent switchings of the electric motor. To do so, shut cock K_1 (in this case an excess pressure of 330-350 mm Hg is registered in the dynamic cavity of the МРД-106 transmitter) and gradually open cock K_2 to create a rarefaction in the static cavity of the МРД-126 transmitter corresponding to an altitude of 4800-5200 m. Lamp $Л_2$ (of the "smaller" arm) continues to burn until the rod begins to move. After the servomechanism electric motor has been switched on and off several times lamp $Л_2$ goes out.

Increasing the rarefaction in the static cavity of the МРД-126 transmitter, determine the end of the servomechanism rod movement at the "bigger" arm, i.e. the rarefaction at the end of the stroke, and watch warning lamp $Л_1$ to flash on. The movement of the rod should cease at a rarefaction corresponding to an altitude of 9800-10,200 m.; the"bigger"arm being minimum 93 mm.

The number of engagements of the servomechanism electric motor at a change in rarefaction corresponding to an altitude from 4800-5200 to 9800-10,200 m. should be within 15-33 which is indicated by the counter.

The servomechanism electric motor is started at an altitude drop of maximum 350 m.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Repeat the test in the reversed order, namely:

(a) Gradually shut cock K_2 to reduce the rarefaction in the static cavity of the MPД-I26 transmitter (maintain an excess pressure of 330-350 mm Hg in the dynamic cavity of the MPД-I06 transmitter).

Simultaneously, determine the moment the servomechanism rod begins to move from the "bigger" to the "smaller" arm. After the servomechanism electric motor has been switched on and off several times lamp $Л_I$ goes out. The rod should begin to shift from the "bigger" to the "smaller" arm at a rarefaction corresponding to an altitude of 9300-10,200 m.

Continue to decrease gradually the rarefaction in the static cavity of the MPД-I26 transmitter to determine the end of the rod stroke at the "smaller" arm. The movement of the servomechanism rod should cease at the "smaller" arm at a rarefaction corresponding to an altitude of 4800-5200 m.

Warning lamp $Л_2$ should flash on at the end of the rod stroke at the "smaller" arm.

Check simultaneously the number of on-off positions of the servomechanism electric motor and the altitude drop between two subsequent switchings of the electric motor.

The number of on-off positions should be within 15-33 and the altitude drop between them not more than 350 m.

(b) Operating cock K_1 gradually decrease the excess pressure in the dynamic cavity of the MPД-I06 transmitter with atmospheric pressure in the static cavity of the MPД-I06 and MPД-I26 transmitters to determine the moment the servomechanism rod begins to move from the "smaller" to the "bigger" arm.

The rod should begin to shift at a pressure of 330-350 mm Hg and at that instant warning lamp $Л_2$ goes out.

Decreasing the pressure in the dynamic cavity of the MPД-I06 transmitter register the end of the rod stroke at the "bigger" arm. The motion of the rod should cease at the

"bigger" arm at a minimum pressure of 67 mm Hg.

Warning lamp $Л_I$ should flash on as the rod stops at the "bigger" arm.

Simultaneously check the number of on-off positions of the servomechanism electric motor and the differential pressure between two subsequent switchings of the electric motor.

The number of the electric motor on-off positions should be at least 20 and the differential pressure between them within 5-15 mm Hg.

The testing procedure completed switch off the supply units of the electric circuit and the air system and set all switches at OFF.

Note. All data indicated in this Section are valid only for new or newly repaired automatic system sets. After 100 or 200 hours of operation the test data should correspond to those shown in Fig. 8.

Checking the Insulation Resistance

Resistance of the insulation between the current-carrying parts and the frame should be checked only on the automatic system (servomechanism) with a 500 V megger.

Insulation resistance should be minimum 2 megohms.

Testing the Electric Strength of the Insulation

Perform test using only the automatic system (servomechanism) with 375 V A.C. at 50 c.p.s.

Apply voltage between the frame and current-carrying parts for 1 min.; check to see that the insulation is not punctured.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Note. During test increase voltage gradually to the indicated value, maintain it at this level for 1 min., reduce it to 1/3 (120-130 V) and then cut it off.

Description of the APV-2A Servomechanism

Purpose

The APV-2A servomechanism is designed to follow up the signals coming from the APV-2A control unit by mechanically shifting the rod and to send receipt signals (feedback) to the control unit.

The external view of the servomechanism is shown in Fig.53.

Design and Principle of Operation

The electric circuit of the APV-2A servomechanism is shown in Fig.54.

The APV-2A servomechanism (Fig.55) is connected to the power source via a plug connector. Current fed to terminal 9 of the plug connector actuates the MV-100AII electric motor (terminal 1 of the plug connector is grounded). Worm 80 is mounted on ball bearings on the same axle as the electric motor shaft. Rotation of the worm is communicated to two worm gears 38 and 6. Worm gear 38 is provided with a trapezoidal thread and during rotation shifts rod 17 in an axial direction towards the smaller arm. At the same time worm gear 6 rigidly attached by a Woodruff key on the axle of the APV-2A mismatch transmitter moves the contact block (See Fig.64) in an axial direction towards the worm gear. When rod 17 reaches the position of the "smaller" arm (in this case H equals 90^{+3}_{-1} mm) push rod 71 depresses the button of retraction terminal switch KB-6.

The contact spring of the terminal switch departs from contacts 1-2 and closes contacts 3-4 thereby interrupting the circuit of the control winding of the PPT-40 reversing and braking relay. The PPT-40 relay operates and deenergizes the electric motor which stops due to electrodynamic braking.

Current fed to terminal 4 of the plug connector will cause the MV-100AII electric motor to rotate in the reverse direction. Simultaneously, rod 17 shifts in an axial direction towards the bigger arm. The contact block of the APV-2A mismatch transmitter moves in an axial direction away from worm gear 6.

When rod 17 reaches the position of the bigger arm (in this case H equals 96^{+3}_{-1} mm) push rod 71 depresses the button of the KB-6 terminal switch which pushes the rod out. The contact spring of the terminal switch departs from contacts 1-2 and closes contacts 3-4 thereby interrupting the circuit of the control winding of the reversing and braking relay PPT-40 and switching on the warning lamp. The PPT-40 relay operates and deenergizes the MV-100AII electric motor which stops due to electrodynamic braking. The warning lamp continues to burn.

Design of the APV-2A Servomechanism and Its Elements

The design of the APV-2A servomechanism is shown in Fig.55.

The servomechanism comprises the following units and parts: rod 17, upper housing 12, housing 7, system of crosspieces 45 and 74, worm gears 38 and 6, worm 80, plug connector MP32IMKI2HMI 84, electric motor MV-100AII (Ref.No. 61 and Fig.58), APV-2A mismatch transmitter (Ref.No.1 and Fig.61), terminal switches KB-6 19.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Note. During test increase voltage gradually to the indicated value, maintain it at this level for 1 min., reduce it to 1/3 (120-130 V) and then cut it off.

Description of the APY-2A Servomechanism

Purpose

The APY-2A servomechanism is designed to follow up the signals coming from the APY-2A control unit by mechanically shifting the rod and to send receipt signals (feedback) to the control unit.

An external view of the servomechanism is shown in Fig.55.

Design and Principle of Operation

The electric circuit of the APY-2A servomechanism is shown in Fig.54.

The APY-2A servomechanism (Fig.55) is connected to the power source via a plug connector. Current fed to terminal 9 of the plug connector actuates the MY-100AII electric motor (terminal 1 of the plug connector is grounded). Worm 80 is mounted on ball bearings on the same axle as the electric motor shaft. Rotation of the worm is communicated to two worm gears 38 and 6. Worm gear 38 is provided with a trapezoidal thread and during rotation shifts rod 17 in an axial direction towards the smaller arm. At the same time worm gear 6 rigidly attached by a Woodruff key on the axle of the APY-2A mismatch transmitter moves the contact block (See Fig.64) in an axial direction towards the worm gear. When rod 17 reaches the position of the "smaller" arm (in this case H equals 50^{+3}_{-1} mm) push rod 71 depresses the button of retraction terminal switch KB-6.

The contact spring of the terminal switch departs from contacts 1-2 and closes contacts 3-4 thereby interrupting the circuit of the control winding of the PPT-40 reversing and braking relay. The PPT-40 relay operates and deenergizes the electric motor which stops due to electrodynamic braking.

Current fed to terminal 4 of the plug connector will cause the MY-100AII electric motor to rotate in the reverse direction. Simultaneously, rod 17 shifts in an axial direction towards the bigger arm. The contact block of the APY-2A mismatch transmitter moves in an axial direction away from worm gear 6.

When rod 17 reaches the position of the bigger arm (in this case H equals 96^{+3}_{-1} mm) push rod 71 depresses the button of the KB-6 terminal switch which pushes the rod out. The contact spring of the terminal switch departs from contacts 1-2 and closes contacts 3-4 thereby interrupting the circuit of the control winding of the reversing and braking relay PPT-40 and switching on the warning lamp. The PPT-40 relay operates and deenergizes the MY-100AII electric motor which stops due to electrodynamic braking. The warning lamp continues to burn.

Design of the APY-2A Servomechanism and Its Elements

The design of the APY-2A servomechanism is shown in Fig.55.

The servomechanism comprises the following units and parts: rod 17, upper housing 12, housing 7, system of crosspieces 45 and 74, worm gears 38 and 6, worm 80, plug connector MP32MK12HMI 84, electric motor MY-100AII (Ref.No. 61 and Fig.58), APY-2A mismatch transmitter (Ref.No.1 and Fig.61), terminal switches KB-6 19.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Rod

Rod 17 is composed of two welded steel parts: rod head 29 and a cylinder. The rod head has a boss with a hole to receive crosspiece 45. Besides, the rod head has a special hole accommodating ball bearing No. 1200K 30.

The other end of the cylinder has a trapezoidal thread meshed with worm gear 38. A through cut made in the cylinder middle section supports bolt 34 securing the artificial feel mechanism with ball bearing No. 981065 pressed into its head.

The bolt is attached to the rod cylinder by pin 16 held in place by spring ring 15.

Upper Housing

Upper housing 12 is made of aluminium alloy as a hollow cylinder. The housing is provided with a flange, an ear fastening the rod to the control stick and a boss with a hole for connection with crosspiece 74. The upper part of the housing (on the boss side) terminates in a rectangle with eight pins 33 mounted by four on each side. The ear fastening the rod to the control stick has a hole with pressed-in ball bearing No. 9710672. The upper housing is attached to housing 7 through four holes drilled in the flange. In addition, on the side opposite to the ear fastening the rod to the control stick, the upper housing has a cut for bolt 34 securing the artificial feel mechanism. To enable rod 17 to move correctly from the bigger to the smaller arm and back, the upper housing is provided with bronze bushing 13.

Lock pin 16 is mounted on rod 17 through a hole in the housing. After the lock pin is secured this hole is shut with cover 65 fastened to the upper housing with four screws 66.

Pins 33 support journals 31 and brackets 18 and 55 secured with nuts 32. To prevent the nuts from spontaneous slackening they are centre-punched with a round punch at three points. Terminal switches KB-6 (19) are mounted on brackets 18 and 55 and are fastened to them with screws 48 and nuts 47 and covered with caps 20. The caps are attached to the brackets by screws 49.

The upper housing is fitted onto housing 7 and is fastened to it through a flange with four screws 62. Each pair of the screws is locked with wire.

Housing

Housing 7 cast of aluminium alloy comprises two interlinked hollow cylinders. The joint has two seats for ball bearings 79 which are mounted on the same axle passing in a direction perpendicular to the axes of the cylinders. Ball bearings 79 support worm 80 fixed in the housing with plug 81. To prevent the plug from spontaneous slackening it is centre-punched at four points with a round punch. On the side opposite to plug 81 the housing is provided with a rectilinear platform with four threaded holes at the corners. This platform supports MY-100AII electric motor 61 which is fastened to the housing with four screws 76. Each pair of screws 76 is locked with wire. When mounting the MY-100AII electric motor align the blade of its shaft with the slit in worm 80.

Worm gear 38 on two ball bearings 39 is fitted into the cavity of one of the cylinders. Two distance bushings 36 and 37 pass between the ball bearings. Worm gear 38 and, hence, ball bearings 39 are secured in the housing with nut 42 which is screwed onto the tang of the worm gear and serves to hold the inner race of one ball bearing.

The outer race of this ball bearing is held by cover 41 screwed into the cylinder cavity and secured by screw 40.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Screw 40 is centre-punched at two points with a round punch. To align the axes of worm 80 and worm gear 38 use is made of washers 5 and 35 placed, when necessary, under the outer and inner races of ball bearings 39.

APY-2A mismatch transmitter 1 is installed into the other cylinder of the housing with worm gear 6 fitted in advance onto its axle; position of the worm gear on the axle is adjusted with washers 8 so that axes of worm gear 6 and worm 80 are aligned. The worm gear communicates with the axle of the mismatch transmitter via a Woodruff key and is secured with nut 9 and locknut 10.

The APY-2A mismatch transmitter is fastened by eight screws 3 with the help of two flanges 2 and 4. Screws 3 are locked with wire.

Textolite washer 11 and c[illegible] 78 are provided on the other side of the cylinder. Co[illegible]3 is secured with six screws 77 locked with wire. Co[illegible] 78 and washer 11 have a hole to pass the bunched conductor to the MY-10CAH electric motor.

System of Crosspieces

This system is composed of two steel parts: crosspiece 45 and crosspiece 74. The crosspieces are linked by bolt 46 with slotted nut 26. The slotted nut rests on washer 75. Bolt 46 is locked with cotter pin 27.

The system of crosspieces prevents rod 17 from slipping when the MY-10CAH electric motor is in operation and fastens the spring push rods of the terminal switch system.

Crosspiece 45 is connected with the head of rod 29 by bolt 28 and slotted nut 44 whereas crosspiece 74 is connected with upper housing 12 by bolt 69 with slotted nut 70. Slotted nuts 44 and 70 rest on washers. Bolts 28 and 69 are locked with cotter pins.

The spring push rods of the terminal switch system are fastened as follows. Elbows 73 are attached to crosspiece 74 with screws 22. Screwed into the elbows are threaded bushings 23 locked with nuts 72. Push rods 71 are inserted into the threaded bushings. Spring 24 are fitted onto the push rods. Then nuts 25 and threaded caps 50 are screwed onto threaded bushings 23. Push rods 71 are fastened to the threaded caps by slotted nut 51 and are locked with cotter pins.

The spring push rods of the terminal switch system should be so adjusted on crosspiece 74 as to enable push rods 71 to depress the buttons of terminal switches KB-6 19 strictly in the centre and at a right angle.

This centre-aligned depression of the buttons is attained with the help of adjusting shims 52 placed, when necessary, between crosspiece 74 and elbow 73. The depression at a right angle is ensured by turning elbow 73 around one screw 22. For this purpose the hole for second screw 22 in the elbows has a semi-circular shape enabling the elbow to turn to a certain angle.

After fixing the spring push rods of the terminal switch system drill four holes in the crosspiece to match the holes in elbows 73 and press in pins 21. Centre-punch the pins at two points with a round punch.

Worm Gears

The worm gears are made of bronze.

Worm gear 38 cast integral with the guide nut imparts reciprocating motion to rod 17.

Worm gear 6 rigidly secured on the axle of the APY-2A mismatch transmitter 1 imparts rotary motion to the axle.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Worm

Worm 80 is made of steel. It is a cylinder with a single thread. To support the ball bearings the worm has collared journals.

The longer journal of the worm is provided with a cut to join the blade of the MU-100AP electric motor shaft.

Worm 80, worm gears 38 and 6, the cylinder of rod 17 and all friction faces are coated with a layer of OKB-122-12 grease. The same grease also fills the seat of rod 17 and 2/3 of the vacant space of all ball bearings.

Plug Connector

The plug connector RP32PK18PE1 joins the wires to the APU-2A servomechanism.

The plug connector is a metal body comprising a receptacle and a plug with pins and sockets secured in insulators and with terminal nuts fastening the wires.

The wires are soldered to the pins of the plug in conformity with the diagram shown in Fig. 54

The wires collected in one bunch are encased in wire mesh 82. Gaskets 65 and 66 made of vinyl chloride white plasticate are fitted onto the bunch under the terminal nut of the plug connector receptacle and under collar 67. From collar 67 the wires branch off to separate elements of the servomechanism. Wires 64 join the plug connector with the MU-100AP electric motor. Wires 63 lead to the APU-2A mismatch transmitter. Other wires 56 and 57 are connected to terminal switches KB-6 19. Wires 63 are fastened by two clamps 59 with gaskets 60 made of vinyl chloride white plasticate placed under them. The wires leading to the terminal switches are protected with vinyl chloride sleeves 53 secured with clamps 59. The clamps are attached to upper housing 12 with screws 54. Wires 56 and 57 are protected by cotton bunding 58.

The circuit of the APU-2A servomechanism is made up of grade BPVA wire, 1.5 mm^2 in cross-section (terminals 4,1 and 9 of the plug connector), grade BPVA wire, 0.5 mm^2 in cross-section (terminals 12, 3, 8 and 7 of the plug connector), and grade MGSH, 0.5 mm^2 in cross-section (terminals 11, 2, 5, 6 and 10 of the plug connector).

The wires are attached with solder POS-40. The soldered joints are protected by vinyl chloride sleeves.

Design and Principle of Operation of Separate Elements of the APU-2A Servomechanism

MU-100AP Electric Motor

Purpose

The MU-100AP electric motor mounted in the APU-2A servomechanism is intended to actuate the APU-2A servomechanism and shift the contact block of the feedback and the position indicator potentiometers of the APU-2A mismatch transmitter.

The external view of the electric motor is represented in Fig.56.

Conditions of Application

The conditions of application of the MU-100AP electric motor are the same as for the APU-2A servomechanism.

Specifications

Power	140 W
Voltage	24 V

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Current	11 A
Maximun current	13 A
Initial torque in cold condition	minimum 8.5 kg/cm.
Brakehorse power	1,82 kg/cm.
Rated speed	7500 r.p.m.
Weight	maximum 1.2 kg
Duty	intermittent, 1 min. operation at nominal load, 10-min. interval, after 3 such cycles - interval until the motor completely cools

Armature Winding Data

Total resistance at 20°C	0.297 ohm
Type of winding	lap
Number of parallel branches	2
Number of slots in the armature	11
Number of active wires in the slot	24
Grade of wire	ПЭЛШО
Diameter of bare wire	0,64 mm
Number of commutator segments	33
Sections in the lot	6

Poles

Number of poles	2
Total resistance at 20°C	0.522 ohm
Grade of wire	ПЭШ
Diameter of bare wire	1.0 mm
Number of turns in the coil	78

Brushes

Type of brushes	M-6
Size of brushes	5x6.5x12 mm
Pressure of the springs on the brush	120-180 gr

Ball bearings

From the side of the commutator and drive	magneto-type ball bearings No.6006

The ball bearings are lubricated with МВП (liquid) grease or КВ grease.

Electric Motor Circuit

The electric motor circuit is shown in Fig.57.

The МУ-100АП electric motor is a two-pole, reversible series-wound D.C. type. The electric motor is reversed by changing the polarity of the poles, the direction of the current flow along the armature winding being preserved. For this purpose the electric motor is provided with two independent field windings located at different poles and called windings of right-hand and left-hand rotation.

The electric motor is started by cutting the armature winding and one of the field windings into the circuit. The second, deenergized, field winding is idle. The pole supporting it acts only as a magnetic circuit and receives a forced polarity which is opposite to the polarity of the other pole with winding carrying current.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

When the windings are changed over, the polarity of the poles is reversed and the electric motor rotates in the opposite direction.

WARNING. Never cut in both field windings simultaneously for this may render the electric motor unserviceable.

Design

The design of the МУ-100АП electric motor is shown in Fig.56.

The electric motor is fastened on the АРУ-2А servomechanism by a flange which also serves as the electric motor housing.

The electric motor comprises the following main units and parts: casing 3, armature 5, front housing 1, rear housing 7, protective strap 9, poles 4 with coils 2.

Body

Body 3 is made of a soft steel tube and, in addition to magnetic functions, ensures a mechanical linkage between the electric motor units (armature and housings). Poles 4 with field coils 2 fitted onto them are secured in the body with screws.

Access to the commutator and brushes is provided through the windows made in the body which are shut with protective steel strap 9.

Solid poles 4 made of soft annealed steel are component parts of the electric motor magnetic circuit.

Field coils 2 are made of enamelled copper wire. Flexible grade ПМЛО wires, 1.5 mm^2 in cross-section, are soldered to the joint of the coils and to two vacant leads. The common

wire running from the coils joint is connected with brush holder 10 inside the electric motor while two other wires are brought out through front housing 1 and serve for external connection. The coils are fitted onto the poles and are impregnated with insulating varnish to protect them from mechanical damage.

Armature

Armature 5 comprises a steel shaft, laminated stack, commutator and winding.

The laminated stack is composed of thin laminae of electrical steel to reduce magnetic losses and is pressed onto the shaft between two extreme textolite sheets.

The half-open round slots are located uniformly around the stack circumference.

The commutator is composed of 33 copper segments insulated by micanite laminations and enveloped in a plastic.

The winding made of grade ПЭЛО enamelled copper wire with a silk insulation is uniformly laid in the armature slots and is insulated from the armature. The output leads of the winding are soldered to the commutator segments. To prevent the armature winding from being thrown out of the slots under the action of centrifugal forces arising during rotation, the slots are protected with rigid insulating wedges and a special banding is placed on the armature end winding.

The winding and the armature are impregnated with insulating varnish.

To keep the oil from the ball bearings off the commutator and the armature winding, the bearings are shielded by special oil slingers fitted onto the shaft.

The armature is mounted in housings 1 and 7 on magneto-type ball bearings No.6006.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Front Housing

Front housing 1 with a flange and centering annular juts to join the body and the APV-2A servomechanism is made of aluminium alloy and, in addition to a seat for the ball bearing race, is provided with a hole for the output leads of the field windings and the electric motor armature (from the brushes). Axial play of the armature is taken up by a special adjusting round nut which is installed in the ball bearing seat and bears against the ball bearing race.

Rear Housing

Blind rear housing 7 is cast from aluminium. Inside, the housing is provided with two annular juts. One of them centres the housing when the latter is being mounted into body 3 and the other centres the insulating supporting ring and brush-holders 10 with brushes 6.

The stamped brush-holders with spring-securing pins are rigidly secured on the supporting ring by rivets.

The brush springs are made of strip steel and are shaped as a flat helix. They press against the brushes with a definite permanent force.

To fix the brushes correctly relative to the poles and ensure effective switching, body 3 of the electric motor and rear housing 7 have special marks. If assembly has been performed correctly the marks should align.

The front and rear housings are braced with two bolts 11 passing through body 3 between poles 4.

Protective Strap

Protective strap 9 covers the ports in body 3 on the commutator side. The strap is made of a thin steel sheet with loops at the ends supporting steel threaded spindles splined

at the ends. Attached to the inner surface of the strap is a vitreous insulating tape to fit the strap closely to the housing surface. The strap is braced with the help of an overset bolt.

APV-2A Mismatch Transmitter

Purpose

The APV-2A mismatch transmitter is one of the main elements of the servomechanism; it performs the following functions:

(1) ensures negative feedback between the sensitive element of the APV-2A control unit and the servomechanism;

(2) indicates the position of the APV-2A servomechanism rod.

The external view of the mismatch transmitter is shown in Fig.59.

Conditions of Application

The conditions of application of the APV-2A mismatch transmitter are the same as for the servomechanism.

Main Technical Parameters

Torque required to move the contact block (See Fig.64) along the entire wound section of the position indicator potentiometer (See Fig.63)	maximum 850 gr/cm.
Supply voltage	27 V±10%
Total resistance of the feedback potentiometer (See Fig.62)	550^{+50}_{-20} ohms
Total resistance of the position indicator potentiometer (See Fig.63)	370^{+40}_{-20} ohms

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Contact pressure as measured between the contacts of the contact block and the potentiometer winding . . . . . 25^{+10} gr

Note. When testing for endurance and wear contact pressure may be reduced to 20 gr.

Overheating of the potentiometer wire . . . . . maximum 75°C
Weight . . . . . maximum 0.3 kg

Ball Bearings

From the drive side . . . . . ball bearing 6008
From the side of the detachable end cover . . . . . ball bearing No. 980055

The ball bearings are lubricated with CKB-I22-I2 grease.

Design and Principle of Operation

The electric circuit of the mismatch transmitter is shown in Fig.60 and its design in Fig.61.

The APY-2A mismatch transmitter comprises two adjustable wire-wound electric resistors 18 and 21 (feedback and position indicator potentiometers) mounted in body 6 on axles 2. The body also accommodates contact block 19 on axle 8 passing between the adjustable resistors. The threaded axle end protruding from the body is provided with a keyway to support a worm gear.

Rotating axle 8 moves contact block 19. The contacts of the contact block which are in permanent contact with the resistor of the potentiometers change the value of their

electric resistance which results in a change of the voltage taken from the potentiometers. Consequently, a shift of the contact block along the axle causes variations in the voltage taken from the potentiometers; since the rotation of the axle (shift of the contact block) is transmitted to the kinematic system of the entire APY-2A servomechanism, variation of the voltage taken from the potentiometers ensures feedback between the servomechanism and the control unit and signalling of the servomechanism rod position.

Design

The mismatch transmitter is attached to the APY-2A servomechanism by a flange which serves as the transmitter body.

The mismatch transmitter comprises the following main units and parts: body 6, shield 16, axle 8, feedback potentiometer 18 (See also Fig.62), position indicator potentiometer 21 (See also Fig.63), contact block 19 (See also Fig.64).

B o d y

Body 6 made of aluminium alloy serves for mechanical linkage of all units of the mismatch transmitter and is supported in the APY-2A servomechanism by its flange.

The body is provided with a seat for the ball bearing and a hole to ensure passage of axle 8. Gasket 12 glued to the body bottom is stamped of micarta. Access to potentiometers 18 and 21 and to contact block 19 is provided through two windows cut in the body which are shut with steel casing 14. The casing is fastened to the body with two screws 20. A hole drilled in the body wall accommodates rubber cap 3. The body and shield 16 are joined by means of a centring annular jut provided on the body.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Shield

Duralumin shield 16 is made as a disc with a seat for the ball bearing and a hole for axle 8. Gasket 12 is glued to the shield end. The shield is secured in body 6 with screws 1 and 15. The holes for the screws are drilled at assembly.

Axle

Steel axle 8 rests in the mismatch transmitter on two ball bearings 11 and 30. The ball bearings are secured with slotted nuts 10 and 32. To prevent the slotted nuts from turning off, the axle is locked with cotter pins 9 and 31. Washer 33 is placed under slotted nut 32. The section of the axle in body 6 is provided with a thread for moving contact block 19. The axle end protruding from the body has a keyway for a Woodruff key and a thread to join the worm gear.

Feedback Potentiometer

The feedback potentiometer (Ref.No.18 and Fig.62) is composed of textolite former 5, two lugs 4, two insulating washers 3, two lugs 2 and two insulating washers 1.

Lugs 2 and 4 as well as insulating washers 1 and 3 are fixed from both sides of former 5 on БФ-4 glue.

Winding 6 on the former is made from grade ПЭК wire, 0,1 mm in dia. The wire is wound in close turns without gaps. The wire output ends are attached to lugs 4 with solder ПОС-40. The potentiometer resistance is 550^{+50}_{-20} ohms. The wound wire is coated with БФ-4 glue.

The wire on section А is cleared of enamel on both opposite sides of the potentiometer.

Rod 7 consisting of two soldered segments is attached to lugs 2 of the potentiometer. On both sides of section Б

the potentiometer is painted with red nitroenamel, type ЭП.

The feedback potentiometer is mounted in the body of the mismatch transmitter on axle 2 (See Fig.61); for this purpose the centre of the potentiometer former is provided with a threaded hole.

Position Indicator Potentiometer

The position indicator potentiometer (Ref.No.21 and Fig.63) differs from the feedback potentiometer (See Fig.62) in that its winding 6 is wound around only the middle section of former 5. Hence, its resistance is 370^{+40}_{-20} ohms.

The ends of the position indicator potentiometer (sections Б) are painted with blue ЭП nitroenamel.

Contact Block

The contact block (Ref. No. 19 and Fig.64) secures and moves the contacts which are in permanent contact with the potentiometer resistors along the mismatch transmitter axle.

The contact block has bronze guide nut 2 to which plastic bracket 1 is attached with three rivets 3. Attached to the bracket with screws 4 are bronze runners 5. The screws are secured on glue БФ-4.

Four contacts made of a palladium-iridium alloy are riveted to each runner. The contacts of one runner are intended for the feedback potentiometer whereas the contacts of the other serve the position indicator potentiometer.

The contact block is installed in the body of the mismatch transmitter on axle 8 (See Fig.61) screwed into the threaded hole of the guide nut.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Guide axle 13 passes through the smooth hole in the contact block. One shoulder of axle 13 presses against the bottom of body 6 and the other against shield 16 and is employed to ensure stability of the contact block.

Type KB-6 Terminal Switch

Purpose

Type KB-6 terminal switches (See Ref.No. 19 in Fig.55) are intended to interrupt the circuit of the control winding of the PPR-0 reversing and braking relay with the rod of the servomechanism APY-2A in extreme positions (at the "bigger" and "smaller" arms) and to switch on the warning lamp at the bigger arm.

Conditions of Application

The conditions of application of the type KB-6 terminal switches are the same as for the APY-2A servomechanism.

Main Technical Parameters

Rated voltage	24 V
Rated current at resistive load	10 A
Pressure on the button necessary to change over the contacts	0.45-0.9 kg
Contact pressure	70-150 gr
Button movement prior to the contact change-over	minimum 0.9 mm
Button movement after the contact change-over	minimum 0.5 mm
Weight	minimum 8 gr

The contact group of the terminal switch and all the other parts are encased in a plastic housing. The terminal switch is protected with a plastic cover fastened to the housing with a spring lock.

Never disassemble the terminal switch.

Faulty terminal switches should be removed and replaced by new ones.

Operating and Maintenance Instructions

For mounting on aircraft, operation and possible troubles of the servomechanism see Section II "Operating and Maintenance Instructions".

Maintenance of the Servomechanism

The APY-2A servomechanism removed from aircraft because of a malfunction which cannot be corrected without disassembly is sent to repair shops where it is cleared of dust and dirt and thoroughly examined from outside. Check the servomechanism for proper condition and make sure it is free from dents and cracks (by external examination). After examination ring out all electric circuits to check the resistance of the circuits of the servomechanism elements and locate the faulty element.

The ringing out should be done with a TT-1 or TT-2 tester since it can also be used to measure the resistance of windings.

After the faulty element has been detected proceed to disassemble the servomechanism.

Disassembly of the APY-2A Servomechanism

The APY-2A servomechanism is disassembled into the following main units and parts (Fig.55):

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

АРУ-2А mismatch transmitter 1;
МУ-100АП electric motor 61;
КВ-6 terminal switches 19;
system of crosspieces 45 and 74 with spring push rods in the switch terminal system;
rod 17;
worm gears 6 and 38;
worm 80;
housing 7;
upper housing 12.

Disassembly of the Servomechanism into Units and Parts

Operation 1. Release the wires and remove the plug connector РП32ПК12НШ1 84.

1. Turn out two screws 76 after removing the banding and take off two clamps 59. Remove two gaskets 60.

2. Turn out two screws 54 and remove two clamps.

3. Remove cotton banding 58.

4. Holding the nut with a spanner, remove the screw of collar 67 and pull out the bunched conductor from the collar. Remove gasket 68. Remove the banding under gasket 68.

5. Release the screws fastening the terminal nut of the plug connector and remove gasket 83.

6. Turn off four screws fastening the housing to the plug connector and pull the housing onto the bunched conductor.

7. Push wire mesh 82 onto the bunched conductor.

8. Remove the banding from the wires at the pins of the plug connector. Pull off the varnished silk insulation.

9. Push the vinyl chloride sleeves from the pins of the plug connector onto the wires to expose the soldered joints.

10. Unsolder the wires from the pins of the plug connector.

11. Remove the plug connector and wire mesh 82 from the bunched conductor.

Operation 2. Remove the АРУ-2А mismatch transmitter 1.

1. Remove the banding from screws 3 and turn them out with a screw-driver.

2. Pull АРУ-2А mismatch transmitter 1 from housing 7 together with flanges 2 and 4.

3. Remove locknut 10 and nut 9 with a spanner.

4. Remove worm gear 6 from the axle of the АРУ-2А mismatch transmitter.

Operation 3. Remove worm 80.

1. Turn out plug 81.

2. Remove worm 80.

Operation 4. Remove КВ-6 terminal switches 19.

1. Turn out eight screws 49 and remove two caps 20.

2. Turn out four nuts 47.

3. Turn out four screws 48 and remove two terminal switches КВ-6 19 together with wires 56 and 57.

Operation 5. Remove the system of crosspieces 45 and 74 with the spring push rods of the switch terminal system.

1. Remove cotter pins from bolts 28 and 69.

2. Turn out slotted nuts 44 and 70.

3. Remove washers 43 and pull out bolts 28 and 69.

Operation 6. Remove rod 17.

1. Turn out four screws 66 and take off cover 65.

2. Drive out four screws fastening collar 67 and remove it.

3. Turn manually worm gear 38 to adjust rod 17 so that lock pin 16 is opposite the hole closed with cover 65.

4. Pull spring ring 15 through the hole closed with cover 65.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

5. Remove lock pin 15

6. Pull out bolt 34 securing the artificial feel mechanism

7. Turn out rod 17.

Operation 7. Remove upper housing 12.

1. Remove the banding from four screws 62 and turn them out with a screw-driver.

2. Remove upper housing 12.

Operation 8. Remove the MY-100AII electric motor 61.

1. Remove the banding from six screws 77 and turn them out with a screw-driver.

2. Remove cover 78.

3. Pull out washer 11.

4. Remove the banding from the other two screws 76 and turn them out with a screw-driver.

5. Remove the MY-100AII electric motor.

6. Remove the cotton banding and pull off the wire mesh from the wires.

Operation 9. Remove worm gear 38.

1. Turn out screw 40.

2. Screw off cover 41.

3. Turn out nut 42.

4. Remove worm gear 38 for which purpose slightly depress the worm gear end with a nonmetallic object.

Fault-Finding

Prior to fault-finding blow off the unit removed from the servomechanism with clean compressed air and wipe all external surfaces with a clean cloth after which examine its exteriors and check the ohmic resistance of the windings and the insulation resistance.

Check by external examination:

(a) presence of all parts in conformity with the drawings;

(b) condition of parts (check for nicks, scratches, broken parts, ruptured wires, wear and traces of corrosion);

(c) condition of the contacts, brushes and commutator.

Check the ohmic resistance of the windings. The winding data are given in the Sections "Specifications". Check the insulation resistance of the current-carrying parts relative to the body with a 500-V megger: place one prod of the megger onto the body and connect the other consecutively to all output leads. When cold, the insulation resistance should be minimum 2 megohms.

Disassembly, Repair, Assembly, Adjustment and Testing of the Units

MY-100AII Electric Motor

During the electric motor operation its separate parts and units get worn and unserviceable and should be repaired or replaced. The brushes, commutator and ball bearings are the most susceptible to wear.

Malfunctions may also be caused by slackening of the springs of the brush holders or their breakage due to careless handling, rupture or short-circuit of the field winding and armature.

Wipe the electric motor to be repaired with a cotton cloth soaked in pure gasoline. Examine the parts from outside to check for nicks. Check externally the commutator, brushes and electric motor for proper condition.

Disassemble the electric motor.

D i s a s s e m b l y

During disassembly see to it that all tiny parts - screws, nuts and washers - are not lost.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

While disassembling the MV-100AII electric motor proceed as follows (See Fig.58):

1. Release the attached screw and remove protective strap 9.

2. Turn out two screws and detach the brush wires and the field coil output ends from the brush-holder clamps.

3. Pull out brushes 6 from the clamps of the brush-holders.

4. Remove coupling bolts 11.

5. Remove rear housing 7. For this purpose use a non-metallic rod to slightly depress rear housing 7 gaining access to it through the inspection port of body 3.

6. Remove the armature of electric motor 5.

7. Remove body 3 together with poles 4 and coils 2 from front housing 1 without damaging the wires.

Note. The outer races of the ball bearings should remain in housings 1 and 7 and the inner races together with the balls, on the shaft.

8. Turn out the nuts and remove the supporting ring together with brush-holders 10 from rear housing 7.

Repair of Units and Parts

Detect faults and repair the units and parts of the electric motor.

Armature. Carefully remove all brush dust from the commutator and scrape out carbon dust and dirt from between the commutator segments with a small pointed stick.

1. Check the armature for mechanical damage.

2. Use a 250-or 500-V ohmmeter or megger to check whether the armature winding is in contact with the armature frame.

3. Measure the insulation resistance. If the insulation resistance is below 2 megohms, dry the armature at 110-120°C

with the ball bearings removed until the armature is completely dry and the insulation resistance restored. With the ball bearings on the armature shaft, dry the armature at 50-60°C until it is completely dry.

Remove the ball bearings from the armature shaft only for replacement. When removing the ball bearings take care not to damage the commutator and the oil slingers; replace the damaged slingers.

When replacing the ball bearings remove their outer races from the seats in housings 1 and 7.

Press the ball bearings onto the shaft as follows.

Wash the new ball bearing in pure aircraft gasoline and heat it up in pure mineral oil up to 80°C. After this use a bronze bushing with a bore exceeding the shaft diameter by 0.5-1 mm to fit the ball bearing onto the shaft gently tapping the bushing with a hammer.

WARNING! Never tap the cage or the outer race of the ball bearing with a hammer.

4. Check the armature winding for rupture and short-circuit in conformity with the diagram shown in Fig.65.

Feed current from the storage battery to the commutator via the brushes and rheostat and slowly rotate the armature to measure voltage between two adjacent commutator segments with a millivoltmeter.

If between any adjacent segments the voltage is higher than between other adjacent segments, it means that there is a rupture between the first two segments or the contact between the wires of the armature winding and the commutator segments is loose (poor soldering).

If the voltage between any two adjacent commutator segments is lower than between another pair of segments or is equal to zero, it testifies to a short-circuit in the section of the

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

While disassembling the MV-100AII electric motor proceed as follows (See Fig.58):

1. Release the attached screw and remove protective strap 9.

2. Turn out two screws and detach the brush wires and the field coil output ends from the brush-holder clamps.

3. Pull out brushes 6 from the clamps of the brush-holders.

4. Remove coupling bolts 11.

5. Remove rear housing 7. For this purpose use a non-metallic rod to slightly depress rear housing 7 gaining access to it through the inspection port of body 3.

6. Remove the armature of electric motor 5.

7. Remove body 3 together with poles 4 and coils 2 from front housing 1 without damaging the wires.

Note. The outer races of the ball bearings should remain in housings 1 and 7 and the inner races together with the balls, on the shaft.

8. Turn out the nuts and remove the supporting ring together with brush-holders 10 from rear housing 7.

Repair of Units and Parts

Detect faults and repair the units and parts of the electric motor.

Armature. Carefully remove all brush dust from the commutator and scrape out carbon dust and dirt from between the commutator segments with a small pointed stick.

1. Check the armature for mechanical damage.

2. Use a 250-or 500-V ohmmeter or megger to check whether the armature winding is in contact with the armature frame.

3. Measure the insulation resistance. If the insulation resistance is below 2 megohms, dry the armature at 110-120°C

with the ball bearings removed until the armature is completely dry and the insulation resistance restored. With the ball bearings on the armature shaft, dry the armature at 50-60°C until it is completely dry.

Remove the ball bearings from the armature shaft only for replacement. When removing the ball bearings take care not to damage the commutator and the oil slingers; replace the damaged slingers.

When replacing the ball bearings remove their outer races from the seats in housings 1 and 7.

Press the ball bearings onto the shaft as follows.

Wash the new ball bearing in pure aircraft gasoline and heat it up in pure mineral oil up to 80°C. After this use a bronze bushing with a bore exceeding the shaft diameter by 0.5-1 mm to fit the ball bearing onto the shaft gently tapping the bushing with a hammer.

WARNING: Never tap the cage or the outer race of the ball bearing with a hammer.

4. Check the armature winding for rupture and short-circuit in conformity with the diagram shown in Fig.65.

Feed current from the storage battery to the commutator via the brushes and rheostat and slowly rotate the armature to measure voltage between two adjacent commutator segments with a millivoltmeter.

If between any adjacent segments the voltage is higher than between other adjacent segments, it means that there is a rupture between the first two segments or the contact between the wires of the armature winding and the commutator segments is loose (poor soldering).

If the voltage between any two adjacent commutator segments is lower than between another pair of segments or is equal to zero, it testifies to a short-circuit in the section of the

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

armature winding connected with the first two segments or to a short-circuit between these two segments.

5. Wipe the commutator with a clean cotton cloth soaked in gasoline and polish its working surface with sandpaper or emery cloth No.170 or No.200.

On detecting scratches, nocks or excessive wear on the commutator surface, work it on a turning lathe until the faults are completely removed. After this, measure the commutator runout and groove the space between the bars to a depth of 0.5 mm. The length of the ungrooved section of the commutator at the lugs should be maximum 1 mm. The permissible runout of the commutator is 0.015 mm.

Body. Remove dust and dirt from the body interior with compressed air.

1. Check the body for mechanical damage.

2. Measure the insulation resistance of the field winding relative to the body. If the insulation resistance is below 2 megohms, dry the body together with the coils.

If the field winding is ruptured or short-circuited replace the body.

Ball bearings. Wash the ball bearings in gasoline, try them for easy and smooth rotation and make sure they do not jam and are not corroded.

Replace faulty ball bearings following the method outlined above.

Housing on the commutator side. Remove brush dust from the internal surface of the housing and the brush-holder clamps. Check the clamps for nicks and other damage.

Measure the insulation resistance of the brush-holders relative to the housing. If the insulation resistance is below 2 megohms find the defective place on the housing and remedy the trouble.

Check the condition of the brush springs.

Note. Check the housing on the commutator side together with the supporting ring.

Brushes. Replace damaged and worn brushes (when they are sunk in the brush-holder clamp). Lap the new brushes to the commutator, one after another, according to the diagram shown in Fig.66. Proceed as follows:

Place a strip of sandpaper or emery cloth No.170 or No.200 with a width equal to the length of the commutator and a length equal to 300-400 mm to cover 180° of the commutator with the gritty surface towards the brushes. Pass the ends of the sandpaper or emery cloth out through the windows made in the body. Fit the brush into the seat of the brush-holder, lower the brush spring and move the sandpaper or emery cloth by the ends along the commutator both ways until the brush is tightly fitted to the commutator. Lapping should not decrease the brush length by more than 0.5-0.6 mm, otherwise the service life of the brush will be shortened.

Grind the brushes with the electric motor running idle at 3-12 V.

About 70% of all surface of the ground brushes contacting the commutator should be glossy.

After lapping and grinding the brushes, blow off the electric motor with pure compressed air to remove the brush dust.

If the new brushes have been lapped in advance (on a mandrel or dummy commutator) do not lap them on the electric motor again; only grind them slightly with the electric motor running.

Other parts. Determine the degree of fitness of all parts of the electric motor. Replace the holding parts with stripped-off thread and damaged splines. Restore the damaged anticorrosive and insulating coatings of the electric motor parts with insulating varnishes.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Assembly of the Electric Motor

The electric motor assembly is the reverse of disassembly. During assembly handle the parts carefully so as not to damage them.

1. Fit the supporting ring with brush-holders 10 (See Fig.58) on rear housing 7 and fasten it with screws and nuts.

2. Place body 3 together with poles 4 and coils 2 on front housing 1 passing the coil wires through the holes in the housing. Align the control marks on the housing and body.

3. Fit in the electric motor armature 5.

4. Place rear housing 7 on body 3. Align the control mark on the body with that on the housing.

5. Screw in coupling bolts 11. Place spring washers under the bolt heads.

6. Fit brushes 6 into the clamps of the brush-holders.

7. Connect the brush wires and the leads of the field coils to the clamps of the brush-holders.

8. Cover the electric motor with protective strap 9.

Note. The electric motor should be covered with protective strap 9 only after testing.

Before assembly remove all dirt and accumulated brush dust from all units and parts and wipe the commutator with a clean cotton cloth soaked in pure gasoline. Without removing the inner races of the ball bearings from the journals of the armature shaft and the outer races from the seats in the housings thoroughly wash the ball bearings with pure gasoline until the grease is completely removed and dry the armature in the open until all gasoline evaporates.

Check for nicks and dents on the cage of the ball bearings, for traces of corrosion on the balls and the races.

Check the ball bearings for easy and smooth rotation without jamming. If any of the above troubles persists replace the ball bearings.

Apply grade NBII (liquid) or KB grease into the ball bearings so as to coat the balls and the races with a thin layer.

Excessive lubrication is harmful since during rotation of the armature grease settles on the surface of rear housing 7 and brush-holders 10 and together with brush dust forms contamination which weakens the insulation resistance.

Make sure the brushes fit tightly to the commutator and move easily (without jamming and play) in the clamps of the brush-holders.

During assembly take care to ensure an axial play of the armature equal to the play in the ball bearings. The axial play of the armature is adjusted by tightening a special nut. After axial play has been adjusted centre-punch the nut.

After assembly check the electric motor armature for easy rotation, with the brushes raised, turning manually the protruding shaft end. Due to the axial play, with the housings not misaligned and the armature not in contact with the poles and brush-holders, rotation of the armature should be easy and without jamming. In case of a stiff and jerky rotation disassemble the electric motor, correct the malfunction and assemble it again.

Grind finally the brushes as instructed above.

Test the assembled electric motor for right-hand and left-hand rotation at idle run at 8-12 V and then at the rated load and voltage (See Section "Testing the Electric Motor").

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Testing the Electric Motor

Test Circuit

For testing the electric motor a 24-30-V D.C. power source ensuring a load of 50 A is required.

The key circuit for testing MV-100AII electric motors is represented in Fig.67.

The power source is a supply unit with a D.C. generator. The voltage of the D.C. generator is adjusted by rheostat R_1 cut into the circuit of the field winding. The electric motor of the supply unit (minimum 1.5 kW) is powered through a magnetic starter from a 220-380-V A.C. mains. Its supply circuit incorporates safety fuses. The electric motor is actuated by a magnetic starter.

The voltage of the D.C. generator and the current consumed by the MV-100AII electric motor are indicated by voltmeter M-340 marked off from 0 to 30 V and by ammeter M-340 reading from 0 to 50 A.

The MV-100AII electric motor is started by the K-50A contactor operated by button B_1. If the contactor is not available, the electric motor can be actuated with a knife switch. Switch $П_I$ mounted in the supply circuit reverses the direction of the electric motor rotation.

The electric motors under test are loaded by an electromagnetic balance-brake having a loading moment up to 10 kg/cm and a supply current of 30 V. The electromagnetic balance-brake is actuated by button B_2. Slide rheostat R_2 cut in series with the winding of the balance-brake changes the loading moment.

Operation of the Circuit and Testing Procedure

Prior to cutting in the circuit, mount the electric motor on a special stand of the balance-brake. Connect its

shaft by means of a coupling clutch with the shaft of the balance-brake armature which is an aluminium disc rotating in the magnetic field of the electromagnets.

Switch on the magnetic starter and adjust the necessary supply voltage on the voltmeter. Then switch on the winding of the balance-brake, contactor K-50A of the electric motor supply line and one of the windings of the MV-100AII electric motor.

WARNING. Before switching on contactor K-50A do not forget to cut in the winding of the balance-brake electromagnet since under full voltage the MV-100AII electric motor with no load develops an excessive rotational speed which may cause a breakdown.

The electric motor begins to rotate thus bringing into motion the armature of the balance-brake.

The magnetic flux induced by the winding of the balance-brake, interacting with the electric field of the balance-brake armature, creates a braking moment which causes the body of the balance-brake electromagnet with the suspended load to turn to a certain angle.

The deflection of the scale from the mean (zero) position, with the brake idle, is fixed by a pointer secured on the body of the brake electromagnet and indicates the value of the loading moment on the electric motor shaft.

The rated loading moment is adjusted on the electric motor by changing voltage across the winding of the brake electromagnet with slide rheostat R_2.

Prior to carrying out tests check the graduation of the balance-brake by suspending a load to the body of the electromagnetic brake.

The value of the loading moment is found from the formula:

$$M = P \times l,$$

where P is the weight of the suspended load in kg;

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

l is the distance from the centre of the balance-brake body to the centre of gravity (middle point) of the load in cm.

The nominal ratings of the electric motor are checked at the rated torque and supply current of 24 V, the duty being one minute of operation followed by a ten minute interval; in all, perform three such cycles after which cool down the motor completely.

The current consumed by the electric motor is registered by the ammeter and its speed by a tachometer.

The test results are considered satisfactory if the required current does not exceed 11 A and the speed of rotation is 7500 r.p.m.

Then use a 500-V megger to measure the insulation resistance of the electric motor which should not be below 2 megohms.

The radial runout of the commutator is measured with a special indicator with a reading value of 0.001 mm.

The results are considered satisfactory if the radial runout of the commutator is not above 0.02 mm.

APV-2A Mismatch Transmitter

Disassembly

The APV-2A mismatch transmitter is disassembled in the following sequence (See Fig.61).

1. Turn out two screws 20 and remove casing 14.
2. Turn out screw 15 and screw off cover 17.
3. Remove cotter pin 31. Holding axle 8 by the key-way with a special spanner turn out slotted nut 32. Remove washer 33.
4. Holding contact block 19 with one hand, remove with the other axle 8 from the mismatch transmitter.

5. Drive out screw 1 and remove shield 16 by gently pushing it with a non-metallic rod through the inspection port of body 6.
6. Remove banding 26.
7. Pull off axle 13.
8. Remove feedback potentiometer 18 and position indicator potentiometer 21 from body 6 carefully passing the wires through the hole in cap 3.
9. Turn out axles 2 from potentiometers 18 and 21.
10. Remove contact block 19 from body 6.
11. Take off cap 3.

Repair of Units and Parts

Remove dust and grease from all parts and thoroughly examine them from outside.

During external examination determine the degree of fitness of all units and parts. Replace faulty units and parts.

Measure the resistance of feedback potentiometer 18 and position indicator potentiometer 21. The resistance values of the potentiometers are given in the Section "Specifications".

Re-connect the torn-off leads of the potentiometers by soldering grade МГСД wires, 0.5 mm^2 in cross-section, using solder ПОС-40.

Check the ball bearings for easy and smooth rotation; jamming and corrosion are not permissible. Replace the faulty ball bearings.

Measure the insulation resistance. The insulation resistance should be minimum 2 megohms.

Assembly

The assembly of the APV-2A mismatch transmitter is the reverse of disassembly.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

1. Fit cap 3 onto body 6.

2. Insert contact block 19 into body 6.

3. Screw axles 2 into potentiometers 18 and 21.

4. Install feedback potentiometer 18 and position indicator potentiometer 21 into body 6 passing the bunched conductor through the hole in cap 3.

5. Mount axle 13.

6. Fit in shield 16 and secure screw 1 on glue BF-4.

Note. When replacing shield 16 or body 6 during repair drill and cut the holes for screws 1 and 15 elsewhere (near the former ones).

7. Place banding 26 and coat it with shellac varnish.

8. Holding contact block 19 with one hand turn in axle 8 with the other.

9. Fit washer 33. Holding axle 8 by the keyway with a special spanner, turn slotted nut 32. Lock axle 8 with cotter pin 31.

10. Screw on cover 17 and turn in screw 15. Place a spring washer under the screw head.

11. Mount casing 14 and turn in two screws 20.

Before assembling the mismatch transmitter apply a thin coat of grease OKB-122-2 to the threading of the revolving parts and all friction faces.

Parts 8 and 19, 18 and 2 and also 21 and 2 should be so selected as to ensure an easy rotation. These parts should have no axial play.

When assembling the mismatch transmitter take up axial play of axle 8 by tightening slotted nut 32; axial play must not be perceptible when applying a 0.5-kg alternating load along the axle.

Axial play of axles 2 should not exceed 0.1 mm. It is adjusted by washers 7.

After assembly make sure the pressure of the contacts on the winding of the potentiometers on both sides is 25-35 gr. Obtain this pressure by bending the lugs of the contact block runner.

A torque applied to axle 8 necessary to move contact block 19 along the entire section of the winding of the position indicator potentiometer 21 should be maximum 850 gr/cm.

A d j u s t i n g

1. Adjust feedback potentiometer 18 and position indicator potentiometer 21 so that the distance from the walls of the mismatch transmitter to the end-faces of the potentiometers on both sides is equal. Adjust by turning axles 2.

2. Adjust contact block 19 so that the contacts of the contact block are located across the winding input section of position indicator potentiometer 21 on the side of cover 17 (in this case the rod of the APV-2A servomechanism should be set for the bigger arm.

Adjust by turning axle 8.

Assembly of the APV-2A Servomechanism

Before assembly repair the parts composing the servomechanism. Proceed as follows:

Remove dirt and grease from all parts and thoroughly examine them from outside. Determine the degree of their fitness. Replace faulty parts.

Check for nicks and chipped teeth on the worm gears, worm and rod. Replace damaged parts.

Check all ball bearings for easy and smooth rotation, for jamming and corrosion. Replace faulty ball bearings.

Re-connect the torn-off wires by soldering grade BMA wires, 0.5 mm^2 in cross-section, using POS-40 solder.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Replace the faulty terminal switches (type KB-6).

The insulation resistance of all current-carrying parts relative to the body should be minimum 2 megohms.

Determine the degree of fitness of all small parts of the servomechanism. Replace the holding parts with stripped-off thread and splines. After this proceed to assemble the servomechanism.

Assemble the servomechanism in the following sequence (See Fig.55).

Operation 1. Assembly of the reduction gear.

1. Fit worm gear 38 into housing 7.
2. Screw on nut 42.
3. Centre-punch nut 42 to lock it.
4. Screw on cover 41.
5. Turn in screw 40.
6. Centre-punch screw 40 to lock it.

Note. Axial play of worm gear 38 should not exceed 0.05 mm.

7. Fix worm 80.
8. Screw in plug 81.
9. Centre-punch plug 81 to lock it in four points.

Note. Screw in plug 81 until end play of worm 80 is taken up. Never overstrain the plug.

10. Fix a Woodruff key into the keyway of the axle of the dummy APY-2A mismatch transmitter, which has no contact block 19 (See Fig.61).
11. Fit worm gear 6 onto the axle of the dummy mismatch transmitter APY-2A.
12. Screw on nut 9.
13. Screw on locknut 10.
14. Mount the APY-2A dummy mismatch transmitter into housing 7.
15. Fit flanges 2 and 4 into housing 7.

16. Fasten flanges 2 and 4 with eight screws 3.

Note. When assembling the reduction gear align the axles of worm gears 6 and 38 with the axle of worm 80 by means of compensating washers 8,5 and 35 placed whenever necessary.

When assembling the reduction gear obtain a smooth rotation of all worm gears without jerks and jamming.

Operation 2. Running in the reduction gear.

1. Link the reduction gear with the MY-100AT electric motor on the stand.
2. Run in the reduction gear in one direction for one hour.
3. Run in the reduction gear in the other direction for one hour.

Simultaneously, feed the MY-100AT electric motor with reduced voltage so that its speed does not exceed the ratod value.

Note. When running in the reduqtion gear lubricate worm gears 6 and 38 and worm 80 with kerosene.

After running in, the reduction gear output shaft should turn, with worm gears 6 and 38 in any angular position, by a torque not exceeding 20 gr/cm.

After the reduction gear has been run in, wash it with gasoline, dry and oil with CKB-122-12 grease. Apply a small amount of grease to the teeth of the worm gears and the worm threading, rotate the reduction gear to distribute evenly the grease and remove excess grease with tissue-paper.

Check the rotation of the reduction gear output shaft. The reduction gear output shaft should turn under a torque not exceeding 50 gr/cm.

Operation 3. Remove the dummy APY-2A mismatch transmitter.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

1. Turn off eight screws 3 with a screw-driver.

2. Remove the dummy APY-2A mismatch transmitter together with flanges 2 and 4 from housing 7.

3. Turn off locknut 10 and nut 9 with a spanner.

4. Remove worm gear 6 from the axle of the dummy APY-2A mismatch transmitter.

Operation 4. Mounting the MY-100AII electric motor 61.

1. Place the wire mesh onto the bunched conductor of the MY-100AII electric motor and fix cotton bandings on its both sides. Insulate the bunched conductor under the ends of the wire mesh with varnished silk.

2. Coat the cotton bandings with shellac varnish.

3. Mount the MY-100AII electric motor on housing 7. Do not fail to align the blade of the electric motor shaft end with the slit in worm 80.

4. Turn in four screws 76 with a screw-driver.

5. Fit in washer 11 passing the bunched conductor from the electric motor through its slot.

6. Mount cover 78 passing the bunched conductor from the electric motor through its hole.

7. Fasten cover 78 with six screws 77.

8. Lock screws 77 with wire.

Operation 5. Mounting upper housing 12.

1. Place upper housing 12 on housing 7.

2. Turn in four screws 62.

3. Lock screws 62 with wire in pairs.

Operation 6. Installing rod 17.

1. Screw rod 17 into worm gear 38 so that distance H is approximately 96 mm.

Operation 7. Fitting in crosspieces 45 and 74 with the spring push rods of the terminal switch system.

1. Fix crosspiece 74 on the boss of upper housing 12.

2. Insert bolt 69 into the hole in upper housing 12 and crosspiece 74.

3. Screw on slotted nut 70. Place a washer under the slotted nut.

4. Lock bolt 69 with a cotter pin.

5. Place crosspiece 45 on the boss of rod 17.

6. Insert bolt 28 into the hole of rod 17 and crosspiece 45.

7. Screw on slotted nut 44. Place washer 43 under the slotted nut.

8. Lock bolt 28 with a cotter pin.

Operation 8. Mounting the KB-6 terminal switches 19.

1. Fix the KB-6 terminal switch of the smaller arm (rod retracted) together with wires 56 onto bracket 18.

2. Fasten the terminal switch to the bracket with two screws 48.

3. Turn two nuts 47 onto screws 48.

4. Place cap 20 on the terminal switch.

5. Secure the cap with four screws 49. Place spring washers under the screw heads.

6. Fix the KB-6 terminal switch of the bigger arm (rod extended) together with wires 57 on bracket 55.

7. Fasten the terminal switch to the bracket with two screws 48.

8. Turn two nuts 47 onto screws 48.

9. Place cap 20 on the terminal switch.

10. Secure the cap with four screws 49. Place spring washers under the screw heads.

Operation 9. Mounting the plug connector MP32IIK12HH1 84.

1. Fit a Woodruff key into the keyway in the axle of the APY-2A mismatch transmitter 1.

2. Fix worm gear 6 onto the axle of the mismatch transmitter APY-2A.

Note. Fit on this mismatch transmitter worm gear 6 removed from the dummy mismatch transmitter with which reduction gear was run in.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

3. Screw on nut 9.

4. Screw on locknut 10.

5. Arrange wires 56, 57, 63 and 64 into one bunch.

6. Fit wire mesh 82 onto the bunch.

7. Fit the body of the plug connector [illegible] onto the bunch.

Note. In this case do not install the APY-2A mismatch transmitter 1 into housing 7.

8. Join the wires to the terminals of the plug connector [illegible] with solder [illegible] as shown in Fig.54.

9. Protect the soldered joints with vinyl chloride sleeves.

Note. Make sure that the electric motor winding meant for retracting the rod is connected with terminal 9 of the plug connector and the winding for extending the rod, with terminal 4.

10. Insulate the wires at the terminals of the plug connector with varnished silk; pull one end of wire mesh 82 onto the insulation and place a cotton banding.

11. Coat the cotton banding with shellac varnish.

12. Connect the body of the plug connector with the plug connectors by four screws.

13. Place gasket 83 in position and turn in the screws fastening the terminal nut of the plug connector.

Operation 10. Fitting in the bolt securing artificial feel mechanism 34.

1. Connect the APY-2A servomechanism to the supply source (as shown in Fig.68).

2. Cut in knife-switch P.

3. Jogging switch [illegible] with terminal [illegible] (smaller arm) adjust rod 17 (See Fig.55) of the servomechanism so that the hole in the rod is opposite the hole in upper housing 12 closed with cover 65.

4. Disconnect the servomechanism from the power source.

5. Fix the fastening bolt 34 of the artificial feel mechanism.

6. Fix lockpin 16 through the hole in upper housing 12.

7. Fasten lockpin 16 with spring ring 15.

8. Mount cover 65.

9. Fasten the cover with four screws 66. Secure the screws on glue [illegible]-4.

Adjusting the APY-2A Servomechanism

The process consists in adjusting the extreme positions of rod 17 and is carried out in the following sequence.

1. Turn off two nuts 72.

2. Screw out two threaded bushings 23 from elbows 73 by threaded cap 50.

3. Mount the servomechanism on the test device (See Fig.74) and secure it in position.

4. Connect the servomechanism to the power source (See Fig.68).

5. Cut in knife-switch P.

6. Set manually the servomechanism arm (distance H) to the booster at 96^{+2}_{-1} mm.

Note. Adjust the arm carefully, by operating switch [illegible] with terminal [illegible] (bigger arm) intermittently so as not to wedge the [illegible] electric motor if the KB-6 terminal switch of the bigger arm is out of adjustment.

7. Screw threaded plug 23 into elbow 73 of the push rod of the bigger arm terminal switch and carefully turn it by threaded cap 50 until the terminal switch of the bigger arm operates and the warning lamp flashes on.

8. Screw on nut 72.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

9. Secure nut 72 with a seal.

10 Check the servomechanism manually for wedging with the arm to the booster (distance H) equalling 48 mm.

Note. Adjust the rod of the servomechanism to an arm of 48 mm carefully by jogging switch II with terminal III (smaller arm) so as not to wedge the MY-10CAII electric motor, if the KB-6 switch of the smaller arm is out of adjustment.

11. Set the rod of the servomechanism manually to the bigger arm.

12. Adjust manually the servomechanism arm (distance H) to the booster equal to 50^{+3}_{-0} mm.

Note. Adjust the arm carefully by jogging switch II with terminal III (smaller arm) so as not to wedge the MY-10CAII electric motor if the KB-6 terminal switch of the smaller arm is out of adjustment.

13. Screw threaded plug 23 into elbow 73 of the push rod of the smaller arm terminal switch and carefully turn it by threaded cap 50 until the terminal switch of the smaller arm operates.

14. Screw on nut 72.

15. Seal nut 72.

16. Set the rod of the servomechanism manually to the bigger arm.

Finishing Jobs on the APY-2A Servomechanism

1. Mount the APY-2A mismatch transmitter in housing 7.
2. Fit flanges 2 and 4 in housing 7.
3. Fasten flanges 2 and 4 with eight screws 3.
4. Lock screws 3 with wire.
5. Place clamps 59 onto wires 56 and 57.

6. Fasten clamps 59 with screws 54. Install the screws on glue БФ-4.

7. Place cotton banding 58.

8. Coat cotton banding 58 with shellac varnish.

9. Fit collar 67 on upper housing 12 and secure it with four screws. Lock the screws with wire.

10. Place a cotton banding on the common bunched conductor under collar 67 and coat the banding with shellac varnish.

11. Place the bunch in collar 67.

12. Insert gasket 68 between the bunch and the collar.

13. Fasten the bunch in the collar with a screw and nut. Install the nut on glue БФ-4.

14. Turn off two screws 76.

15. Fit two clamps 59 onto wires 63.

16. Place gaskets 60 under clamps 59.

17. Turn in two screws 76. Place clamps 59 under the screw heads.

18. Lock screws 76 with wire by pairs.

19. Seal all screws and nuts with red nitroenamel ЭП.

Before assembling the servomechanism select parts 38 and 17 so that the axial play of rod 17 is not over 0.1 mm.

When assembling the servomechanism align the axes of worm gears 6 and 38 with the axis of worm 80 by means of compensating washers 8, 5 and 35 which are placed whenever necessary.

Make sure that push rods 71 press against the buttons of the KB-6 terminal switches strictly in the centre and at 90° to the plane of brackets 18 and 55.

All flexible joints of the servomechanism should be lubricated with CKS-122-12 grease. The same grease should be filled into the seat of servomechanism rod 17.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

The amount of grease in the ball bearings should not exceed 2/3 of all vacant space between the balls.

Testing the APY-2A Servomechanism

The servomechanism is tested on a special installation whose circuit is shown in Fig.68.

Place the servomechanism on the device shown in Fig. 74 and secure it in position. Cut in knife-switch P.

Connect switch I with terminal МП (smaller arm) and pull in the rod of the servomechanism; the arm to the booster should be equal to 50^{+3}_{-0} mm.

Connect switch II with terminal БП (bigger arm) and push out the rod of the servomechanism; the arm to the booster should be equal to 96^{+2}_{-1} mm.

Cut off power supply. Remove the servomechanism from the device and measure the insulation resistance of all current-carrying circuits relative to the body.

The insulation resistance should be minimum 2 megohms.

Section III

DESCRIPTION OF THE APY-2A POSITION INDICATOR

PURPOSE

The APY-2A position indicator controls the position of the servomechanism in flight.

The position indicator is provided with a scale graduated in km/hr of flight speed and in km. of flight altitude.

The external view of the position indicator is shown in Fig.69.

SPECIFICATIONS

The position indicator is designed to operate under the following conditions:

ambient temperature - from -60°C to +50°C;

relative humidity of the ambient air - up to 98%;

vibration of the fastening joints - at a frequency from 20 to 80 c.p.s. with an amplitude corresponding to an acceleration of 1.5 g;

short-time jolting of the fastening joints - at a frequency from 60 to 100 shocks per minute with an amplitude corresponding to an acceleration of 4 g.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Main Technical Parameters

Speed measurement range	from 500 to 900 km/hr
Flight altitude measurement range	from 5000 to 10,000 m.
Reading value:	
speed scale	100 km.
altitude scale	1 km
Weight	maximum 0.25 kg

OUTFIT

The outfit of the APY-2A position indicator includes:

(a) position indicator, proper;

(b) certificate filled in and signed.

Note. The position indicator in the APY-2A automatic system has one certificate with the system.

DESIGN AND PRINCIPLE OF OPERATION

The position indicator is a voltmeter of the magneto-electric system.

The key circuit of the position indicator is shown in Fig.70.

The position indicator operates on the same principle as the voltmeter of the magneto-electric system, i.e. on the interaction of the magnetic fields of the fixed permanent magnet and the winding of the moving frame carrying current proportional to the applied voltage.

Interaction of those magnetic fields makes the moving frame rotate in one direction or the other depending on the value of the applied voltage.

The force counteracting the rotation of the moving frame is created by two spiral springs which serve at the same time to feed voltage to the moving frame.

The movement of the frame is followed by the pointer. The deflection of the moving frame with the pointer depends on the value of the current passing through the frame and, hence, on the value of the voltage.

DESIGN

The position indicator comprises the following main units and parts: magnetic system, moving system and base.

The design of the position indicator is shown in Fig.71.

Magnetic System

The magnetic system of the position indicator comprises cylindrical permanent magnet 9 with a slot running along its entire length and magnetized along its axis, magnetic circuit 10 and core 7. The active side of frame 3 shifts in the air gap between the magnetic circuit and the core. Magnet 9 is pressed into an aluminium mounting and is provided with profiled pole shoe 11. The profile of the pole shoe determains the nature of the instrument scale. Magnet 9 is fastened to magnetic circuit 10 by two screws.

Moving System

The moving system of the position indicator consists of a frame with winding 3, axle 4, pointer 5, two pivots and two current-carrying spiral springs 6 which create the opposing moment and return the moving system to the initial position.

The moving system is arranged on angle bracket 8. The angle bracket also supports the magnetic screen with scale 12 attached there by means of two screws.

The marks on the scale are covered with luminescent mass.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

The moving system with the magnetic screen and dial is secured on the magnetic circuit with the help of angle bracket 8.

Frame 3 embraces core 7 whose shape allows the moving system to turn around its axis by 240°.

The two ends of axle 4 are fastened in corundum step bearings.

Pointer 5 secured on axle 4 is coated with luminescent mass.

Base

Plastic base 1 carries the mechanism of the position indicator comprising the magnetic and moving systems as well as two bolts with nuts for connecting the electric circuit wires.

A 4000-ohm series resistor is wound in the groove made in the base. The series resistor is protected from damage by steel cover 13 placed on the base which also serves as a magnetic screen.

Housing with Glass

Steel housing 2 accommodates base 1 of the position indicator together with the mechanism.

The housing is provided with a flange fastening the position indicator on the panel by means of four screws.

The glass fitted in the housing keeps dust and dirt off the moving system and protects it from damage.

The housing is attached to the base with four screws.

OPERATING AND MAINTENANCE INSTRUCTIONS

Mounting on Aircraft

The diagram for connecting the position indicator to the automatic system is represented in Fig.11. The position

indicator is secured in the aircraft cockpit on the panel by four screws.

When mounting the position indicator onto the cockpit panel see to it that its terminals have no contact with the frame.

To connect the wires to the position indicator turn off the nuts from each terminal, remove the washers and fit the wire tips onto the terminal rods observing polarity; then place the washers, screw on and tighten the nuts.

Operation

Until the warranted period of service has expired, the position indicator requires no maintenance at all. During operation keep oil, fuel, dirt, etc. off the position indicator.

After the warranted period of service stipulated by the manufacturing plant has expired, remove the position indicator from the aircraft and check whether its service life can be prolonged.

Examine externally the position indicator removed from the aircraft and check calibration of its scale.

If the results of the external inspection are satisfactory the service life can be prolonged. The position indicator is checked by the methods outlined in the Section "Checking the Calibration".

Possible Troubles and Remedies

Trouble	Cause	Remedy
1	2	3
1. Position indicator pointer does not respond to voltage	(a) No or poor contact where connection wires are attached	Eliminate rupture. Check contact where wires are

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

1	2	3
		attached to position indicator
	(b) Broken circuit inside position indicator	Replace position indicator
2. Position indicator pointer responds to voltage by deflecting in opposite direction	Wrong polarity of wires connected to position indicator terminals	Rearrange the wire ends

Maintenance

The position indicator removed from aircraft because of a malfunction which cannot be corrected without disassembly should be replaced.

The position indicators which have been sent to repair shops with a view to prolonging their service life should be examined externally and checked for faults.

Fault-Finding

Prior to detecting faults remove dust and dirt from the position indicator and wipe the external surface with a clean cloth. Then check by external inspection:

(a) outfit - presence of all parts;

(b) condition of part surfaces; check for broken parts, corrosion on terminals, housing, etc.

Checking the Insulation Resistance

Use a 500-V megger to check the insulation resistance of the current-carrying parts relative to the housing; place

one prod of the megger on the housing after removing a layer of paint from this place and connect the other to the terminals. When cold, the insulation resistance should be minimum 10 megohms.

Disassembly

Since the position indicator is based on a magnetoelectric voltmeter and is very complicated in design and adjustment, it should never be disassembled; in case any malfunctions are detected, replace the instrument.

Checking the Calibration

Put the position indicator into the test desk circuit (Fig.72) using clamps with nuts for the purpose.

Prior to mounting the position indicator on the test desk set all switches in OFF (ВЫКЛЮЧЕНО) position and raise the resistance of all rheostats to the maximum value.

Start generator Г and turn on switch B_1. Use rheostat R_1 to obtain 28-29 V across the generator shunt winding.

Check voltage by voltmeter V_1.

Turn on switch B_2 and gradually increasing voltage by potentiometer P_2 determine by voltmeter V_2 whether its readings coincide with those of the position indicator pointer.

The Table of correspondence between the readings of voltmeter V_2 and the markings on the scale of the position indicator is given below.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Speed scale		Altitude scale	
Markings on position indicator scale	Rated voltage across terminals of position indicator, V	Markings on position indicator scale	Rated voltage across terminals of position indicator, V
5	2.7	10	3.0
6	7.5	9	5.5
		8	10.3
7	11.5	7	15.6
8	18	6	21.4
9	26.5	5	26.5

During the test the pointer should move smoothly without jamming. At each given mark of the scale the pointer end should overlap minimum 1/4 and maximum 3/4 of the scale of the intermediate mark. With the power cut off, the end of the pointer should be at the top of the scale zero.

After checking the scale calibration , check the electric strength of the insulation. For this purpose feed 375 V to the terminals and housing from an A.C. source of 50 c.p.s.; maintain this voltage for one minute.

The results are satisfactory if during the test the insulation and coverings are not punctured.

Note. When checking the electric strength of the insulation gradually raise voltage to the indicated value, maintain it at this level for one minute and then reduce it to 1/3 of its value, i.e. to 120 V and cut it off.

APPENDIX I

Slushing, Packing and Storage Instructions for the AFY-2A Automatic System

If after delivering from the Manufacturing plant the servomechanism is sent for storage for any length of time it should be slushed, i.e. its blued and cadmium-plated parts, the rod and the open ball bearings should be coated with protective grease.

Slush the following:

(a) rod of the servomechanism, with OKB-122-12 grease;

(b) open ball bearings, with UNIATIM-201 grease;

(c) blued or cadmium-plated parts, with gun grease or petrolatum.

Before slushing, remove dirt and de-grease the blued and cadmium-plated parts by wiping them with a clean cotton cloth soaked in B-70 gasoline. Then dry the parts by blowing them off with dry compressed air or wiping them with a clean cotton cloth.

Prior to slushing procedure heat the grease up to 70-75°C and apply to the surface in a thin uniform layer using a brush.

Notes. 1. When slushing the protective caps of the servomechanism terminal switches make sure that the slushing compound does not get on the switches since this may cause their failure at low temperatures.

2. During slushing never touch the surfaces coated with protective grease with bare hands. Use knit-wear clean rags or thick paper (waxed, paraffined).

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Never slush the control unit and the position indicator.

The automatic system set is packed into wooden boxes which are sent to the Consumers storehouses.

Pack as follows. The servomechanism is placed in the wooden box on pads secured at the box bottom. On top the servomechanism is fastened with blocks attached to the box cover. The control unit is fixed on a wooden liner with three planks. The liner with the secured control unit is attached to the box bottom by two knurled nuts.

Placed under the liner is a rubber gasket. The top of the control unit is protected from damage during transportation by corrugated cardboard pad glued to the box cover.

The plug connecters of the servomechanism and the control unit are attached to the box bottom with a clamp. The position indicator is stowed in soft packing made of corrugated cardboard and is placed under the servomechanism between the pads.

The external view of the packed automatic system is shown in Fig.73.

The boxes with automatic system sets should not be kept at the Consumer's dumps in the open. Unpack the boxes only in a closed room.

Sweated parts of the automatic system should be immediately wiped with a clean cotton cloth and dried.

The automatic system sets should be kept on wooden racks in a clean, dry, air-conditioned and heated room at +5 to +25°C; daily temperature fluctuations should not exceed 6°C. The sets can be kept in the same boxes in which they were delivered by the Manufacturing plant.

The relative air humidity in the premises should be within 50 and 70%. The premises with the sets should be kept free from any vapours and gases causing corrosion as, for example, vapours of chemicals, sulphur, ammonium or chlorine oxides, etc.

Never keep chemical reagents and volatile matters (acids, alkali, charged storage batteries, etc.) together with the sets.

During storage inspect the boxes every six months. Corrosion detected on steel parts without anti-corrosive coating should be removed with sandpaper No.200 soaked in gun grease, following which the defective spot should be polished with ГОИ paste.

Before cleaning remove the protective grease with a cloth soaked in gasoline (use only non-ethylated gasoline).

After cleaning thoroughly degrease the parts with a clean cloth soaked in gasoline, let them dry and coat them with a layer of protective grease by means of a hair brush.

APPENDIX II

Conversion Table of Excess Pressure for MPI-106 Transmitters

Item No.	Excess pressure		Item No.	Excess pressure	
	kg/m^2	mm Hg		kg/m^2	mm Hg
1	600	45	5	4800	350
2	1200	90	6	5400	400
3	2400	180	7	6000	440
4	3600	265	8	7200	530

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

APPENDIX III

Fixture for Adjusting and Testing the Automatic System

When adjusting and testing the automatic system the servomechanism is secured on a special fixture (Fig.74).

The fixture comprises metal plate 1 with three stands secured on it. Stand 2 supports the servomechanism housing and two stands 5 serve for attachment of the servomechanism with the help of two lugs 3 and wing nuts 4. Graduated rule 6 attached to the fixture serves to measure the servomechanism arm to the power booster. The value is indicated by pointer 7 fastened on the ball bearing of the servomechanism rod.

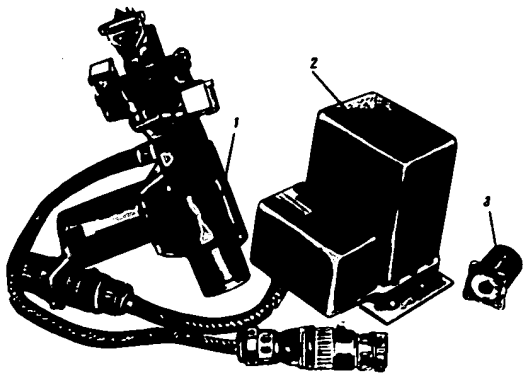


Fig. 1. АРУ-2А Automatic System, External View
1 – automatic unit (servomechanism); 2 – control unit; 3 – position indicator.

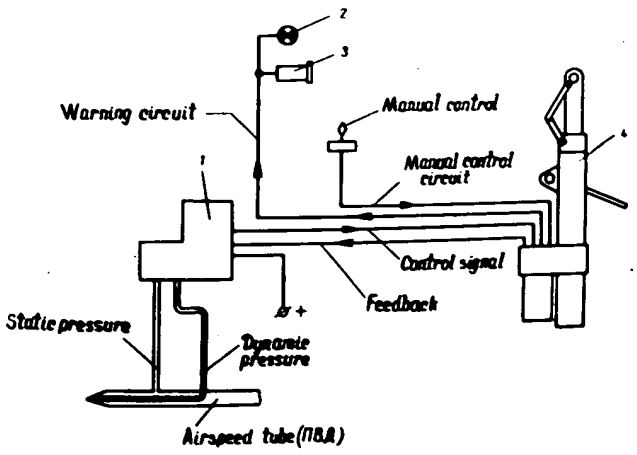


Fig. 2. АРУ-2А Automatic System, Skeleton Diagram
1 – control unit; 2 – warning lamp of take-off and landing control; 3 – position indicator; 4 – servomechanism.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

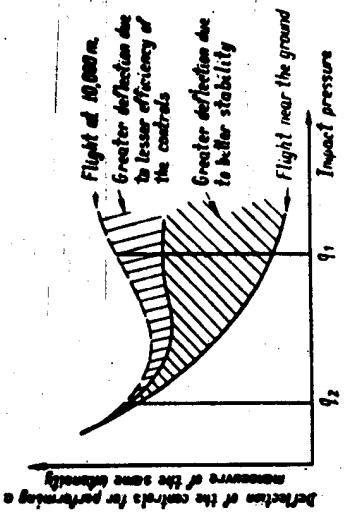

Flight at 10,000 m.
Greater deflection due to lesser efficiency of the controls
Greater deflection due to better stability
Flight near the ground
Impact pressure
Deflection of the controls for performing a manoeuvre of the same intensity

Fig. 4. Effect of Impact Pressure, Aircraft Stability and the Efficiency of the Controls on Controllability

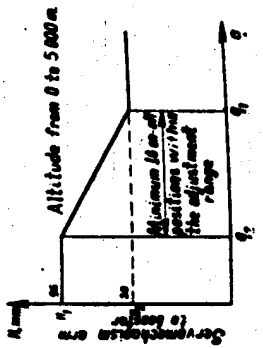


Fig. 5. Adjustment Cycle by Impact Pressure

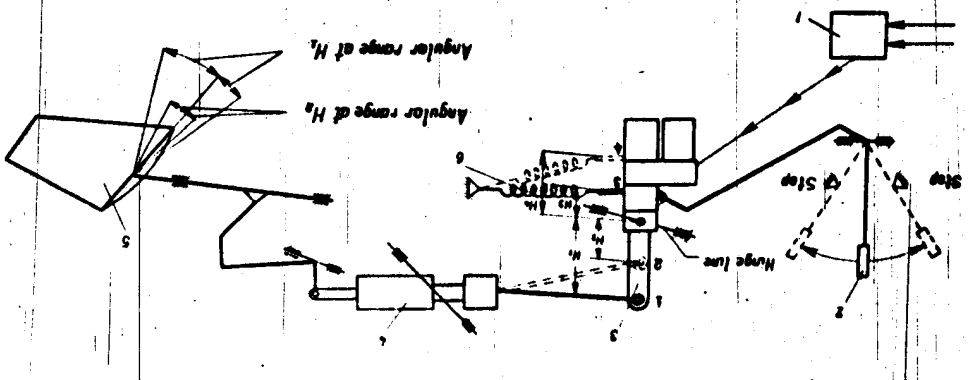


Fig. 3. AP-2A Automatic System Connection to the Pitch Control System. Diagram
1 – control unit 2 – switch 3 – servomechanism 4 – power booster 5 – control surfaces 6 – artificial feel mechanism

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

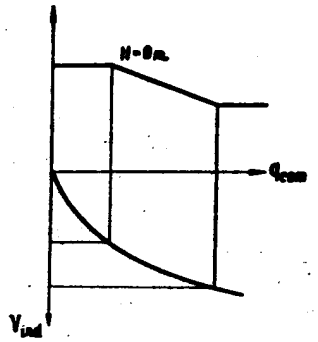


Fig. 6. Relation between Q, Q_{com} and V_{ind}.

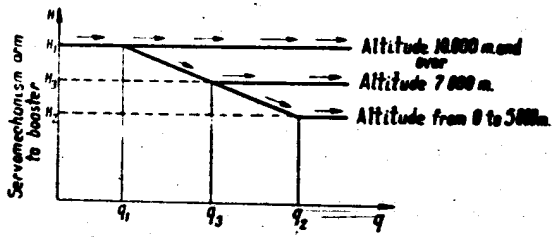


Fig. 7. Altitude Correction

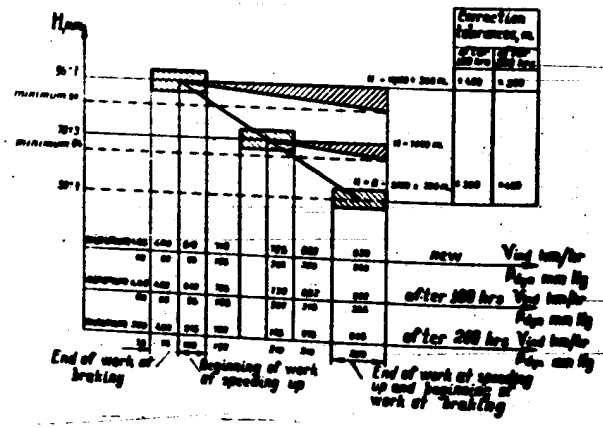

H_{min}
Correction tolerances, m
new
after 100 hrs
after 200 hrs
End of work at braking
Beginning of work at speeding up
End of work at speeding up and beginning of work at braking

Fig. 8. Tolerances for the Preset Performance Cycle of the APУ-2A Automatic System

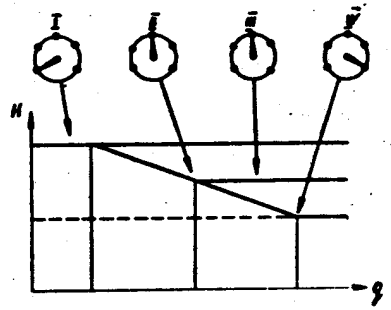


Fig. 9. Operation of the APУ-2 Position Indicator

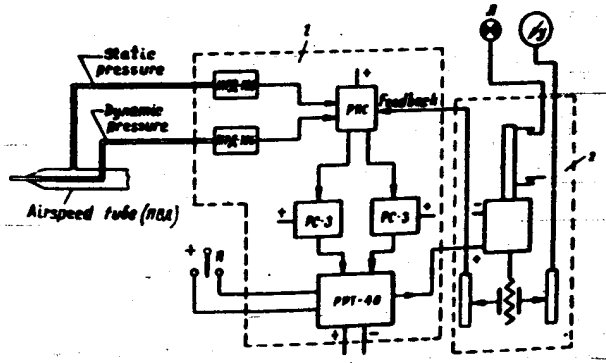


Fig. 10. APУ-2A Automatic System, Block Diagram
1 – control unit; 2 – servomechanism; П – manual control switch; У – position indicator; Ж – warning lamp of take-off and landing position.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

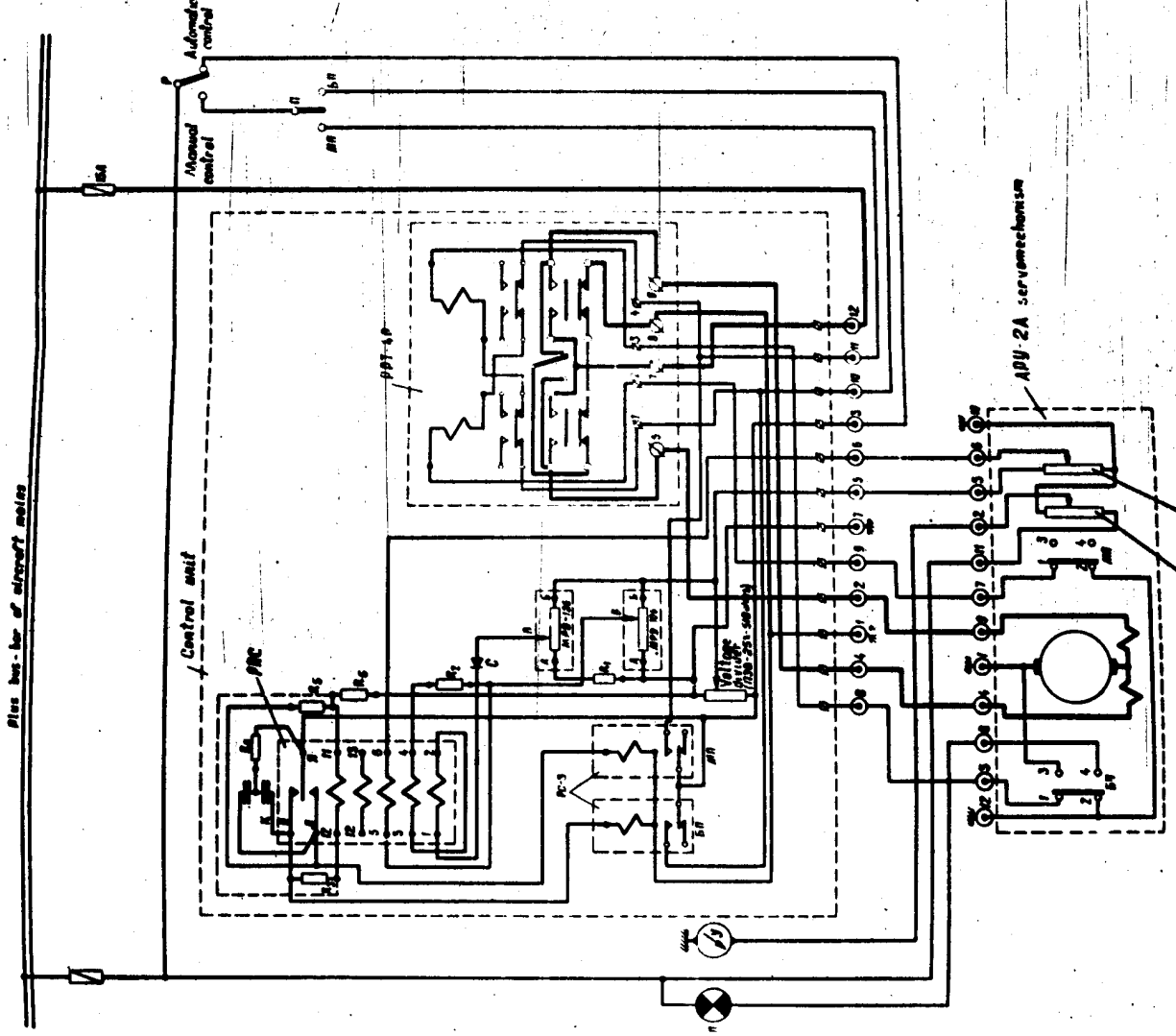


Fig. 11. APU-2A Automatic System Electric Circuit

C – selenium rectifier (valve); У – position indicator; Д – warning lamp of take-off and landing position; R_1, R_2, R_3, R_4, R_5, R_6 – resistors P – knife switch; П – switch of "higher" or "smaller" assy ЭП – "higher" assy ЭП – "smaller" assy К – capacitor

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

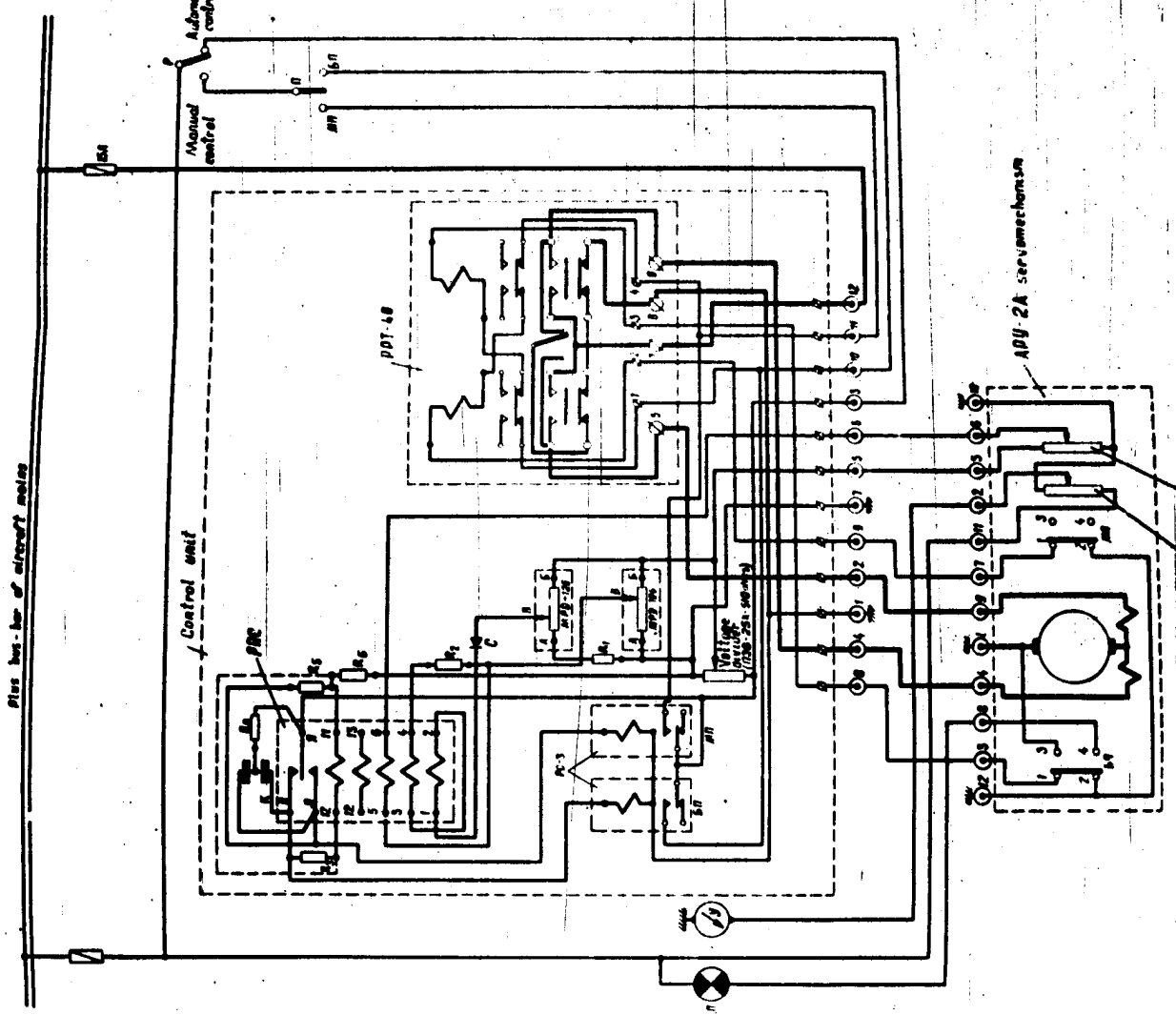


Fig. 11. APU-2A Automatic System Electric Circuit

C – selenium rectifier (valves); У – position indicator; R_1, R_2, R_3, R_4 R_5, R_6 – resistors; Д – warning lamp of take-off and landing position; B_1, B_2 – "higher" and "lower" arm; K – capacitor; П – knife switch; П – switch of "higher" or "lower" arm; III – "higher" arm; VII – "lower" arm.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

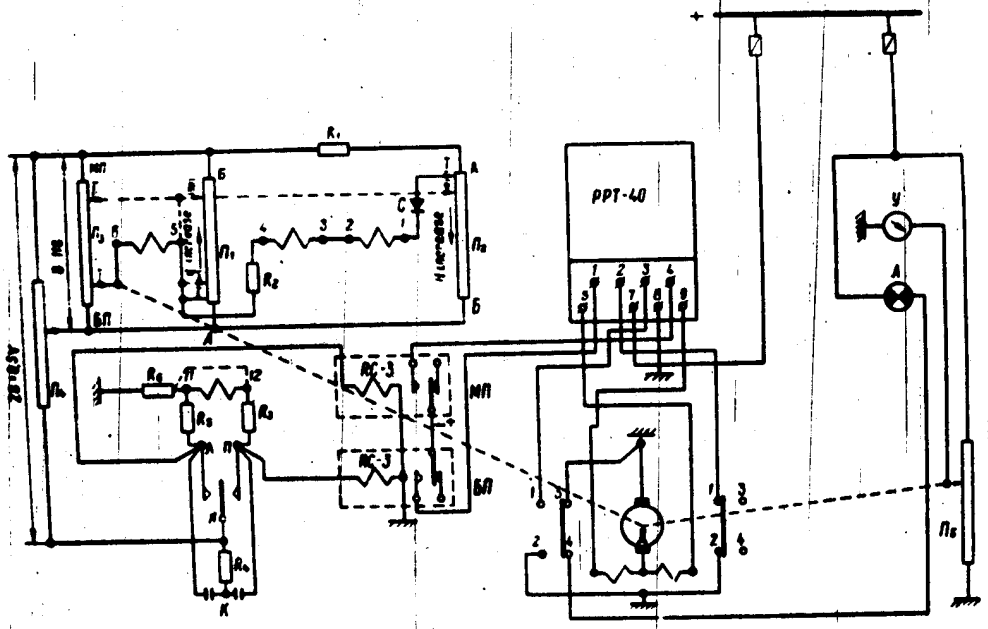


Fig. 12. АРУ-2А Automatic System Servo Circuit

$П_1$ – potentiometer of the МРД-106 transmitter; $П_2$ – potentiometer of the МРД-126 transmitter; $П_3$ – feed-back potentiometer; $П_4$ – resistor ПТП – 250-510 ohms (voltage divider); $П_5$ – position indicator potentiometer; R_1, R_2, R_3, R_4, R_5, R_6 – resistors; С – selenium rectifier; К – capacitor; Д – МУ-188АП electric motor; У – position indicator; Л – warning lamp of take-off and landing position; МП – "smaller" arm; БП – "bigger" arm.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Fig. 13. Chart of the Automatic System Operation

Fig. 14. Operation of the Positive Feedback Circuit

R_3, R_5, R_6 – resistors; 11 and 12 – terminals of the PTC relay.

Fig. 15. Magnetic Fluxes in the PTC Relay

Φ_1, Φ_2 – magnetic fluxes of the relay pickup clockwise and leftwards; 1 – magnetic fluxes of the relay drapes clockwise and leftwards within the positive feedback circuit; 2 – magnetic fluxes of the relay drapes clockwise and leftwards with the positive feedback closed.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

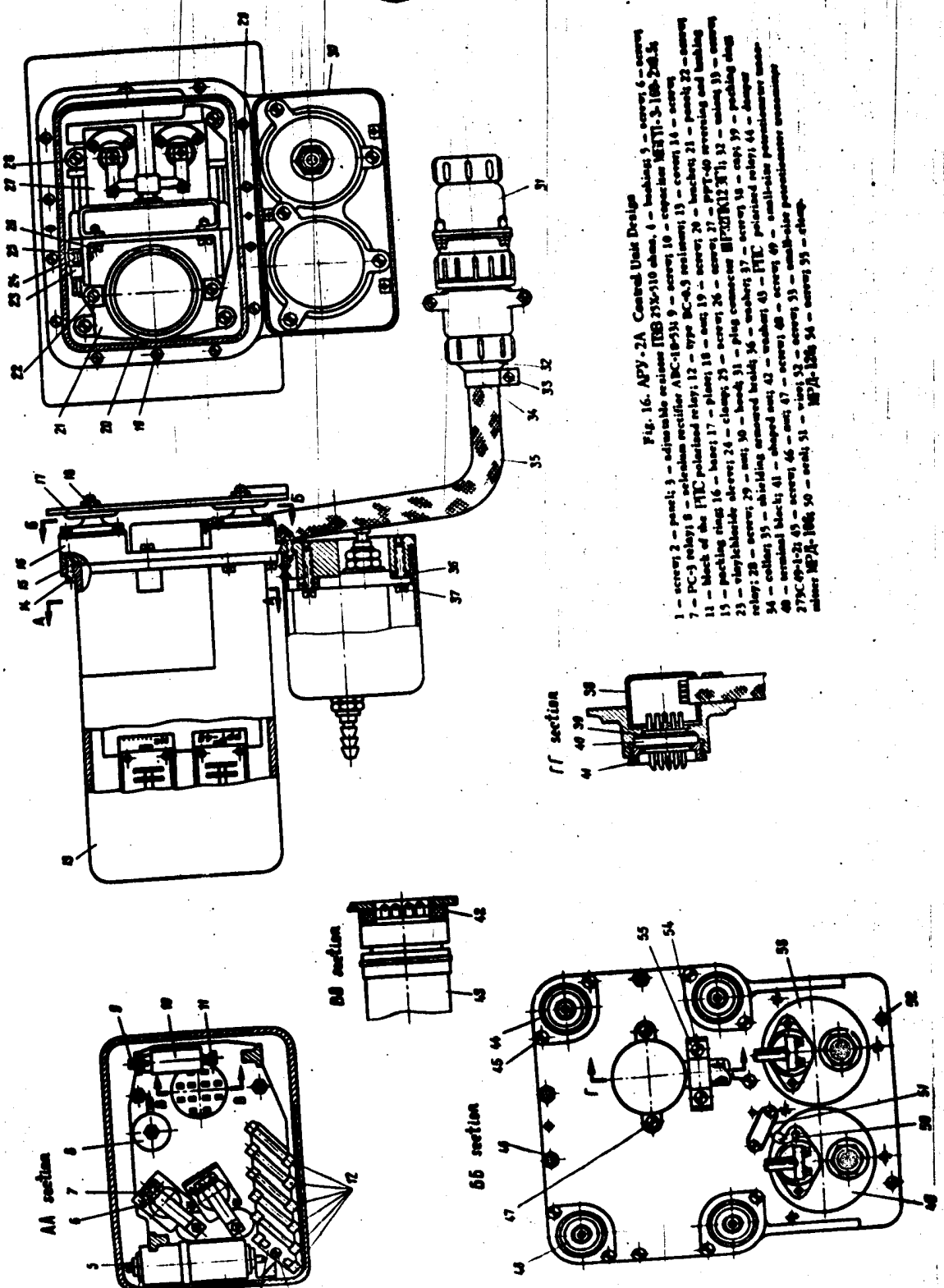


Fig. 16. APY-2A Control Unit Design

1 – screw; 2 – panel; 3 – adjustable resistor ITB 25X-110 ohms; 4 – bushing; 5 – screw; 6 – screw; 7 – PC-5 relay; 8 – selenium rectifier ABC-18-13; 9 – screw; 10 – capacitor MBTI-3-1Ø-2Ø.5; 11 – block of the FTC polarized relay; 12 – type BC-0.5 resistors; 13 – cover; 14 – screw; 15 – packing ring; 16 – base; 17 – plate; 18 – nut; 19 – screw; 20 – bushing; 21 – panel; 22 – screw; 23 – vinylchloride sleeve; 24 – clamp; 25 – screw; 26 – screw; 27 – PTT-40 mounting and bushing; 28 – screw; 29 – nut; 30 – bush; 31 – plug connector BP2DK12-3T; 32 – mixing tip – screw; relay; 38 – screw; 39 – nut; 40 – bush; 41 – shaped nut; 42 – washer; 43 – FTC polarized relay; 44 – damper; 34 – collar; 35 – shielding armored braid; 36 – washer; 37 – screw; 38 – cap; 39 – packing; 40 – terminal block; 41 – shaped nut; 42 – washer; 43 – FTC polarized relay; 44 – damper; 27DC-09-1-21 45 – screw; 46 – nut; 47 – screw; 48 – screw; 49 – screw; 50 – screw; 51 – wire; 52 – screw; 53 – clamp; other MP/A-1Ø6; 54 – screw; 55 – clamp.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

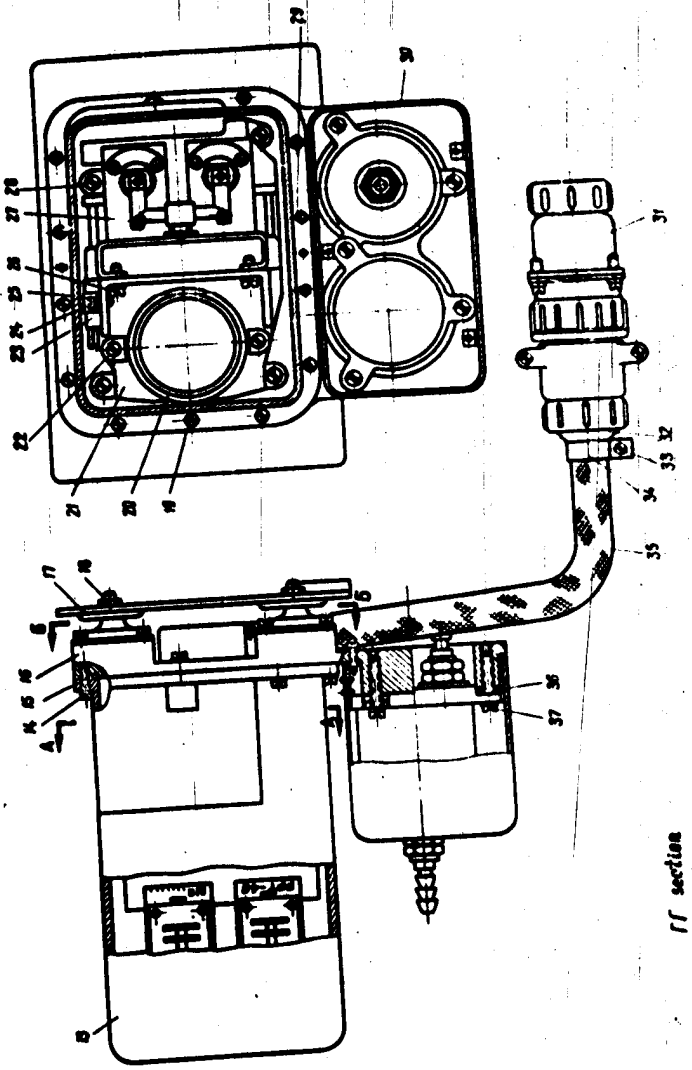


Fig. 16. APY-2A Control Unit Design

1 — screw; 2 — panel; 3 — adjustable resistor ITKB 25X-510 ohm; 4 — housing; 5 — screw; 6 — screw; 7 — PC-3 relay; 8 — selenium rectifier ABC-10-13; 9 — screw; 10 — capacitor KBTI-3-100-2±0.5; 11 — block of the ITEC polarized relay; 12 — type BC-0.3 resistors; 13 — cover; 14 — screw; 15 — packing ring; 16 — base; 17 — plate; 18 — nut; 19 — screw; 20 — bracket; 21 — panel; 22 — screw; 23 — vinylchloride sleeve; 24 — clamp; 25 — screw; 26 — screw; 27 — PPT-40 reversing and locking relay; 28 — screw; 29 — nut; 30 — bush; 31 — plug connector 2PM12B2TT1; 32 — screw; 33 — screw; 34 — collar; 35 — shielding armoured braid; 36 — washer; 37 — screw; 38 — bracket; 39 — screw; 40 — terminal block; 41 — shaped nut; 42 — washer; 43 — ITEC polarized relay; 44 — small-size potentiometer; 45 — screw; 46 — nut; 47 — screw; 48 — screw; 49 — small-size potentiometer connector; 50 — washer; 51 — wire; 52 — screw; 53 — small-size potentiometer connector; 54 — screw; 55 — clamp; 27ЖС-09-1-23 — cable; MRP-1B6 — cable; MRP-1B6 — cable.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

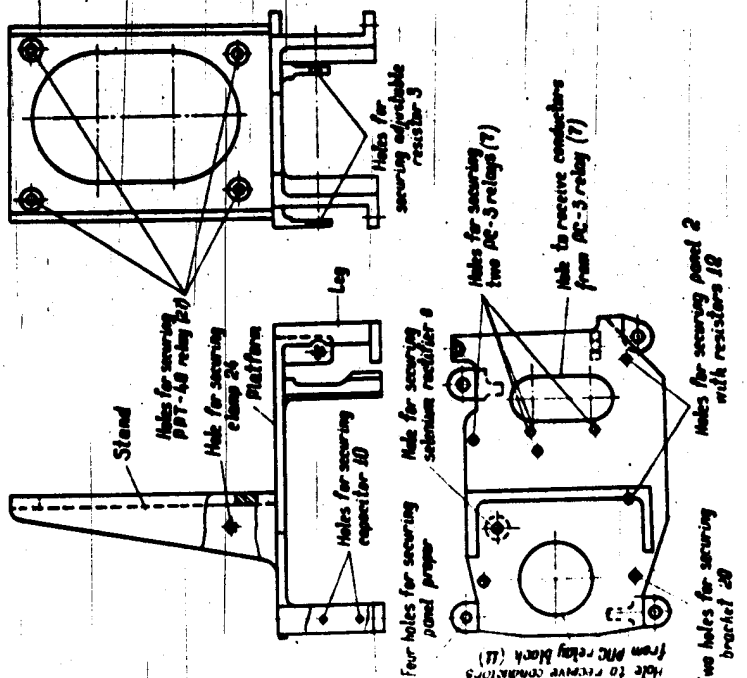

Holes for securing adjustable resistor 3
Holes for securing two RE-3 relays (7)
Hole to receive conductors from RE-3 relay (7)
Leg
Holes for securing PBT-48 relay (10)
Hole for securing clamp 24
Platform
Stand
Hole for securing selenium rectifier 6
Holes for securing panel 2 with resistors 18
Holes for securing capacitor 20
Four holes for securing panel proper
Hole to receive conductors from MK relay block (11)
Two holes for securing bracket 28

Fig. 17. Panel.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

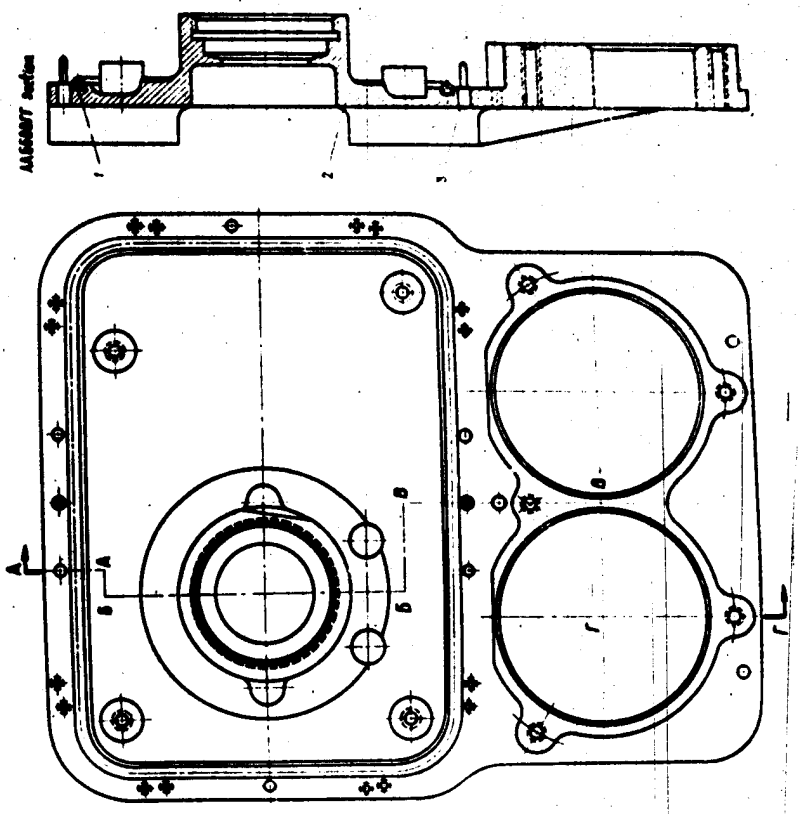


Fig. 19. Door
1 – packing rings; 2 – lever; 3 – lock pin.

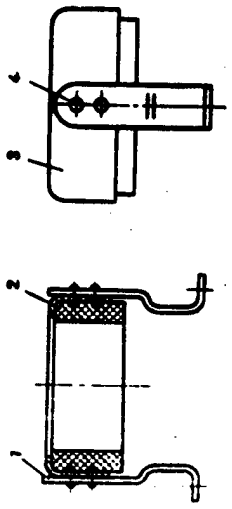


Fig. 18. Bracket
1 – lug; 2 – rubber gasket; 3 – cap; 4 – rivet.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Fig. 20. Terminal Block
1 – body; 2 – terminal.

Fig. 21. Panel
1, 2 – terminal plates; 3 – terminals; 4 – rivet.

Fig. 22. Plate with Dampers
1 – plate; 2 – ring; 3 – damper 277.C.0.0-2; 4 – screw; 5 – washer
6 – spring washer.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

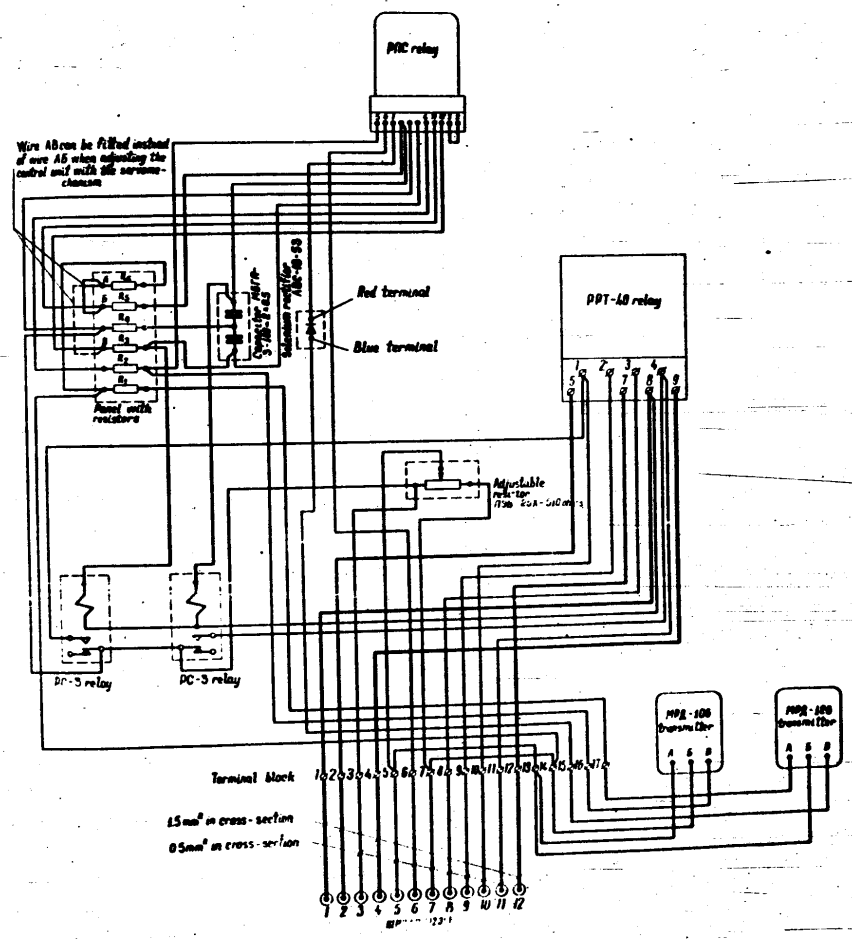


Fig. 23. APY-2A Control Unit Wiring Diagram

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

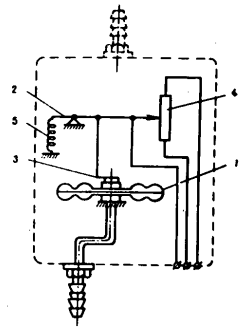


Fig. 26. Key Diagram of the Transmitters
1 – sensitive element; 2 – brush-holder with brushes; 3 – transfer-multiplier mechanism; 4 – potentiometer; 5 – return spring.

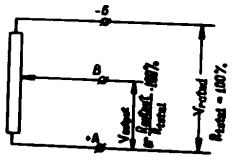


Fig. 27. Electric Circuit of the Transmitters

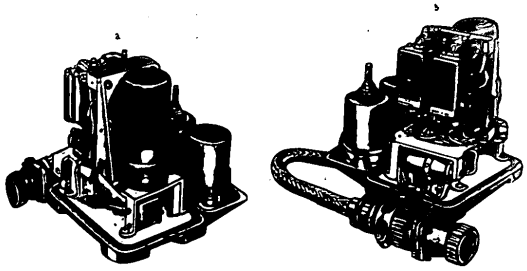


Fig. 24. Arrangement of the Automatic System Separate Parts in the Control Unit
а – view from PTC relay; b – view from the PPT-40 relay.

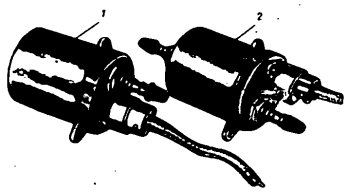


Fig. 25. Small-Size Potentiometer Transmitter, External View
1 – МРД-126 transmitter; 2 – МРД-105 transmitter.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

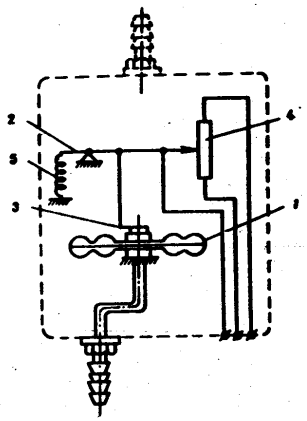


Fig. 26. Key Diagram of the Transmitters
1 – sensitive element; 2 – brush-holder with brushes; 3 – transfer-multiplier mechanism; 4 – potentiometer; 5 – return spring.

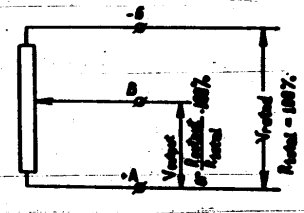


Fig. 27. Electric Circuit of the Transmitters

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

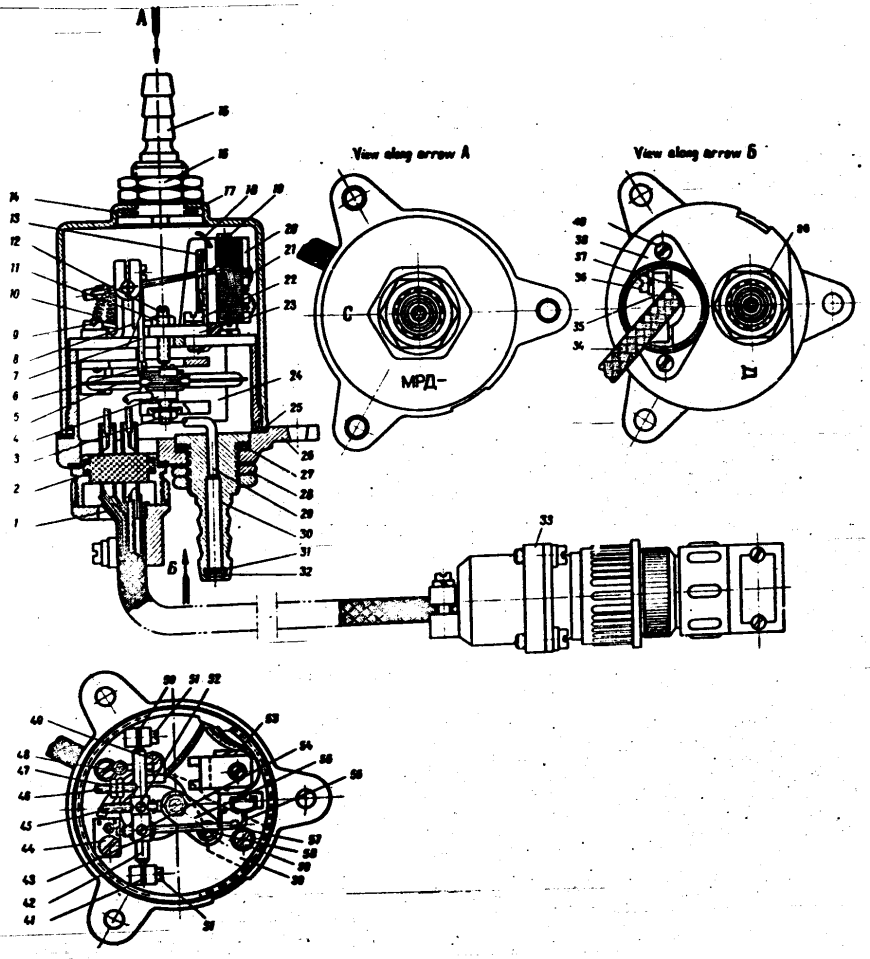


Fig. 28. Transistor Design

1 – output leads; 2 – gasket; 3 – nut; 4 – bottom contact; 5 – ceramic cell; 6 – upper contact; 7 – rod; 8 – clamp; 9 – return spring; 10 – contact-carrying spring; 11 – locknut; 12 – screw; 13 – spring; 14 – gasket; 15 – metal tube; 16 – nut; 17 – housing; 18 – screw; 19 – adjusting screw; 20 – potentiometer brace; 21 – potentiometer; 22 – screw; 23 – axle; 24 – plate; 25 – gasket; 26 – base; 27 – gasket; 28 – nut; 29 – pipe conduit; 30 – tube; 31 – mesh; 32 – ring; 33 – plug connector; 34 – shielding leads; 35 – clamp; 36 – screw; 37 – bushing; 38 – plug connector; 39 – clamp; 40 – screw; 41 – step-punched screw; 42 – axle; 43 – bushing; 44 – screw; 45 – leads; 46 – pin; 47 – nut; 48 – pin; 49 – screw; 50 – adjusting screw; 51 – screw; 52 – screw; 53 – lock washer; 54 – screw; 55 – plate; 56 – brush; 57 – brush-holder; 58, 59 – screw.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

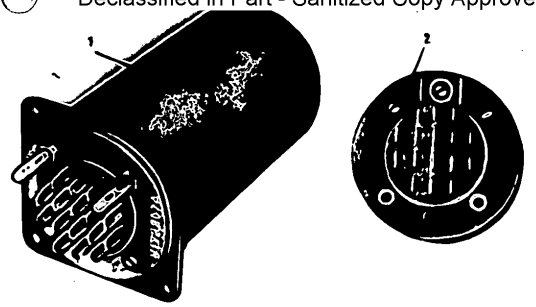
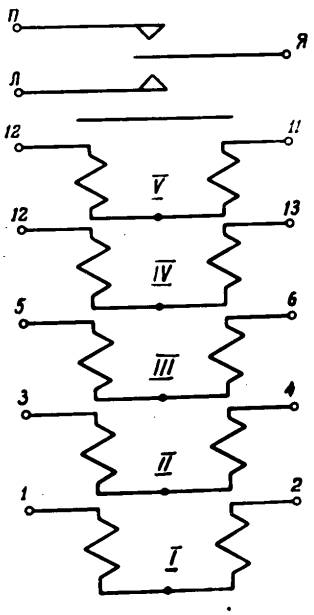


Fig. 29. External View of the РПС Relay
1 – РПС relay; 2 – connector block.



Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

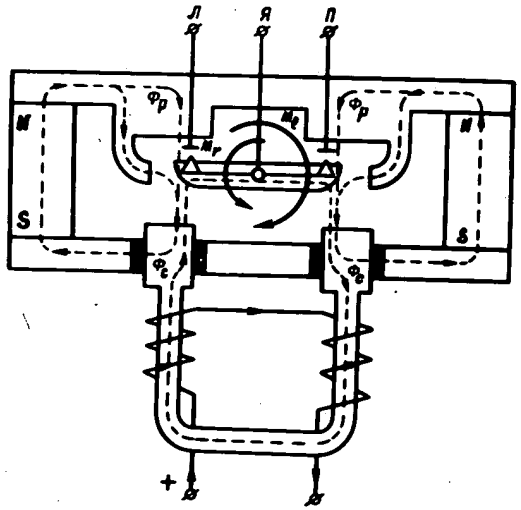


Fig. 31. PTC relay, Magnetic Circuit

N – north pole of permanent magnets; S – south pole of permanent magnets; Φ_p – polarizing magnetic flux; Φ_c – controlling magnetic flux; M_r, M_l – electromagnetic moments of the relay operation rightwards and leftwards.

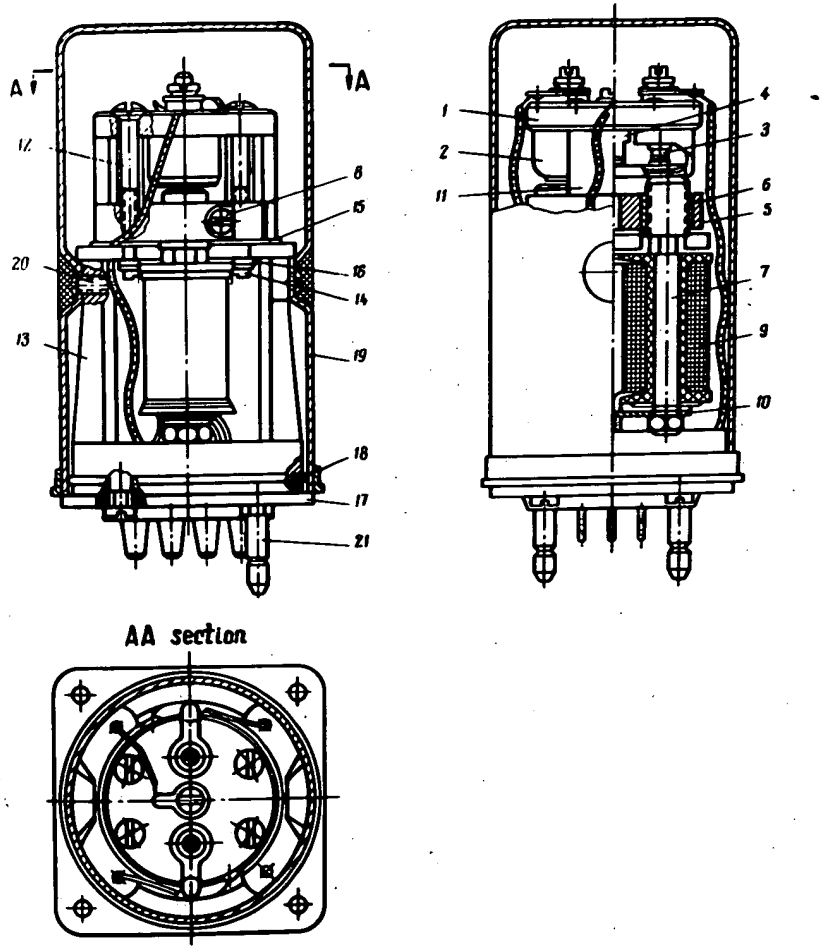


Fig. 32. PTC Relay Design

1 – upper base; 2 – shoes; 3 – contact screws; 4 – bracket; 5 – bottom base; 6 – bushings; 7 – core; 8 – screws; 9 – coil with windings; 10 – jumper; 11 – permanent magnets; 12 – screws; 13 – stand; 14 – screw; 15 – gasket; 16 – bushing; 17 – block; 18 – packing ring; 19 – cover; 20 – screw; 21 – guide pins.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

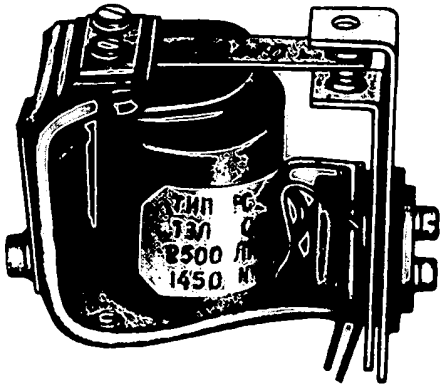


Fig. 33. PC-3 Relay, External View

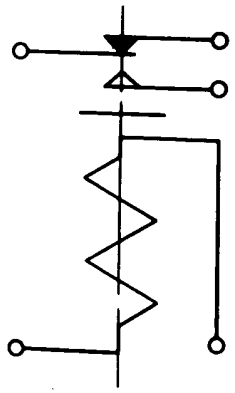
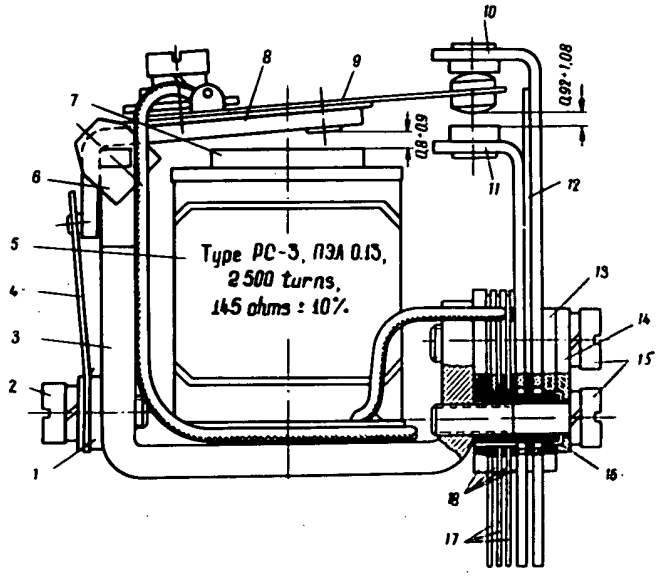


Fig. 34. PC-3 Relay. Key Circuit



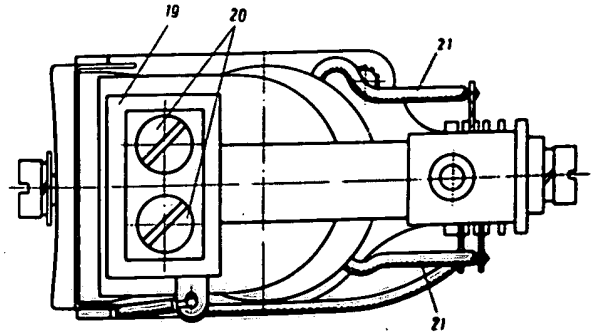


Fig. 35. PC-3 Relay Design

1 – gasket; 2 – screw; 3 – base; 4 – return spring; 5 – coil; 6 – clamp; 7 – core; 8 – armature; 9 – contact spring; 10, 11 – fixed contact bus-bars; 12 – gasket; 13 – gasket; 14 – strap; 15 – screws; 16 – bushing; 17 – output bus-bars; 18 – gasket; 19 – gasket; 20 – screws; 21, 23 – output leads; 22 – screws.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

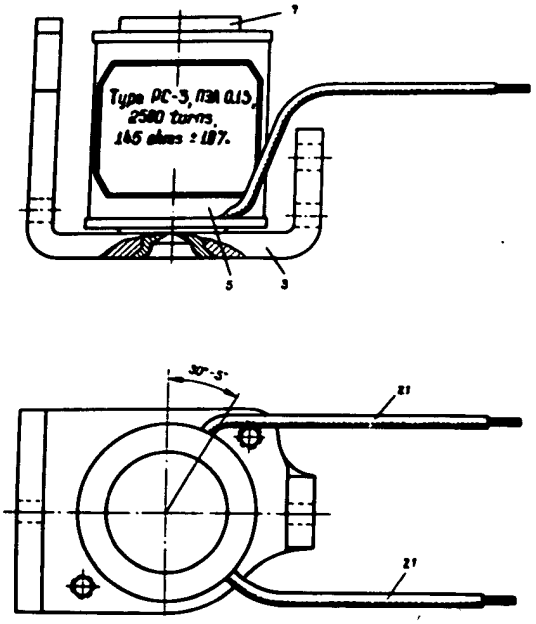


Fig. 36. Base with the Coil
3 – base; 5 – coil; 7 – core; 21 – output leads.

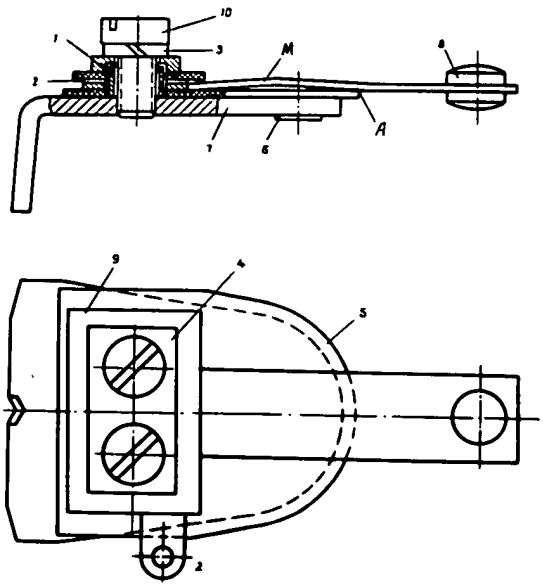


Fig. 37. Armature (Unit)
1 – bushing; 2 – lug; 3 – washer; 4 – strap; 5 – gasket; 6 – rest; 7 – armature; 8 – contact spring; 9 – gaskets; 10 – screw.

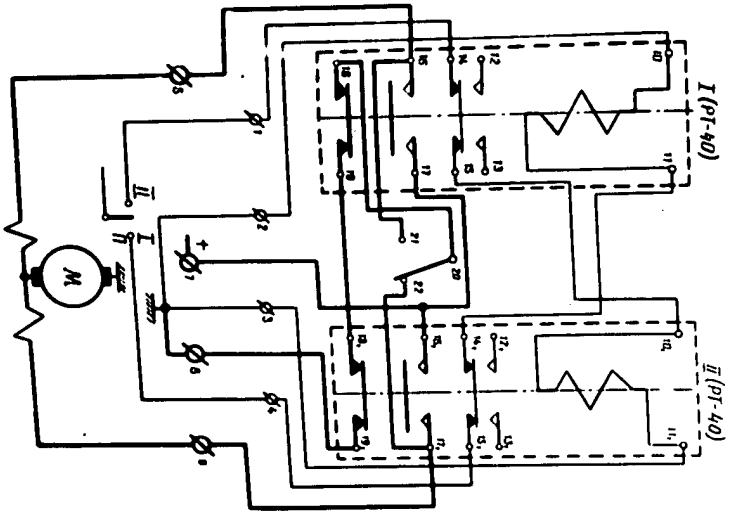


Fig. 39. PPT-40 Relay, Key Circuit

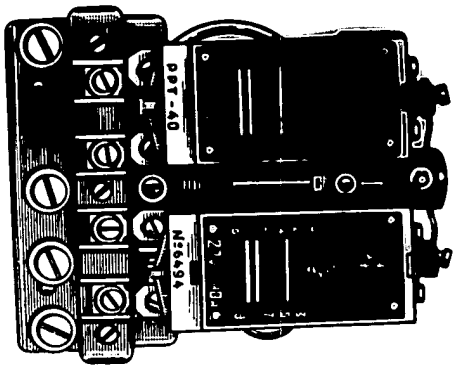


Fig. 38. PPT-40 Relay, External View

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

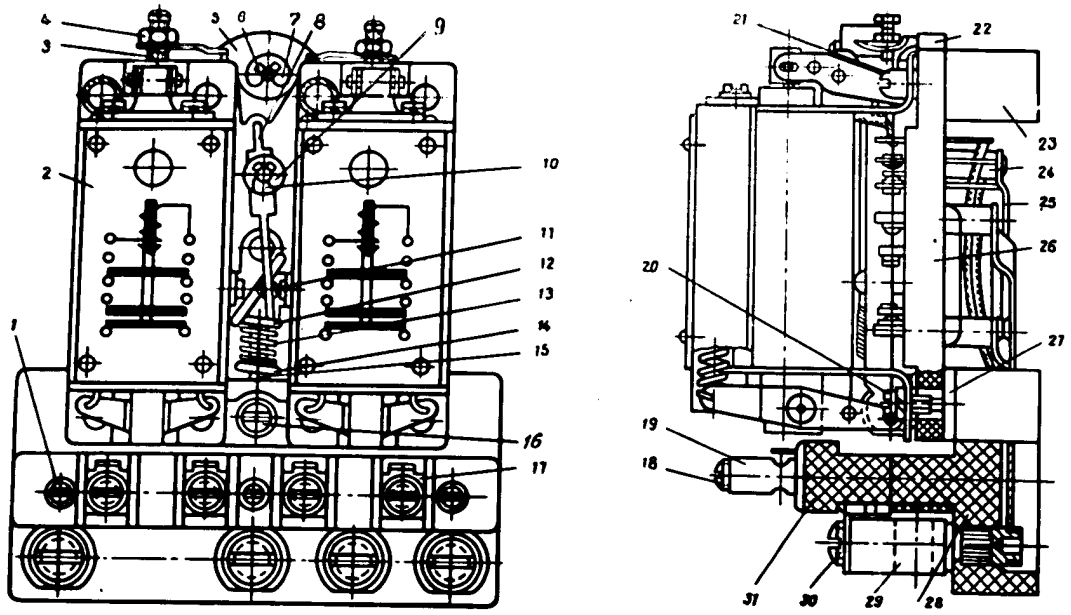


Fig. 40. PPT-40 Relay Design

1 – screw; 2 – PT-40 relay; 3 – screw; 4 – nut; 5 – lever; 6 – axle; 7 – lock washer; 8 – lever; 9 – lock washer; 10 – insulating washer; 11 – contacts; 12 – packing washer; 13 – spring; 14 – thrust washer; 15 – bevel; 16 – screw; 17 – support; 18 – contact screw; 19 – terminal; 20 – screw; 21 – special screw; 22 – panel of the break-make contact; 23 – stand; 24 – contact stand; 25 – bus-bar; 26 – panel of the PT-40 relay; 27 – strip; 28 – panel; 29 – power terminal; 30 – contact power screw; 31 – terminal block.

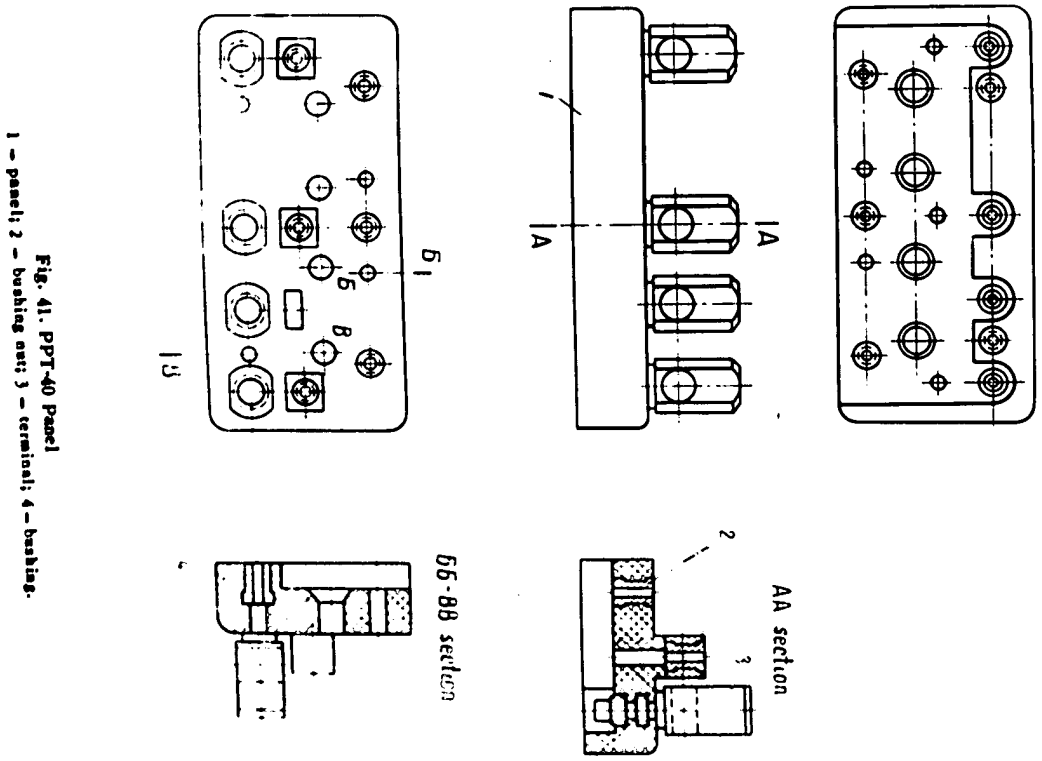


Fig. 41. PPT-40 Panel

1 – panel; 2 – bushing nut; 3 – terminal; 4 – bushing.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

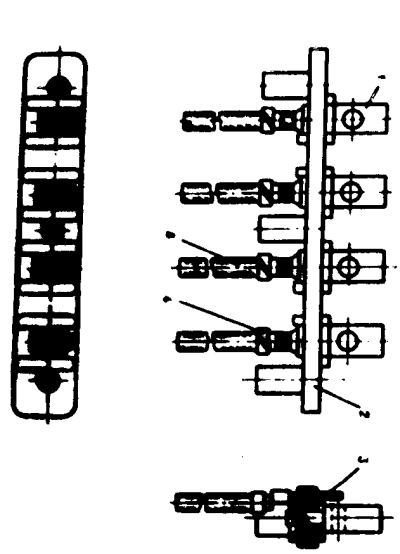
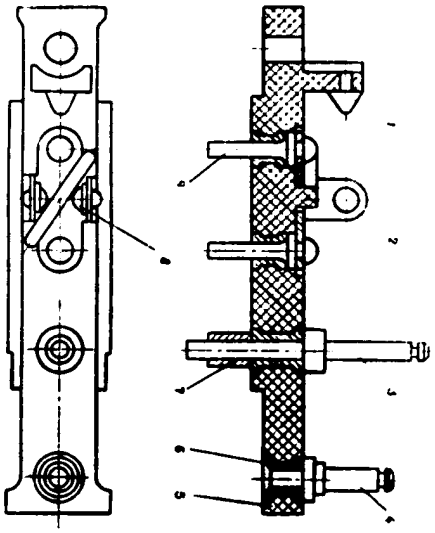
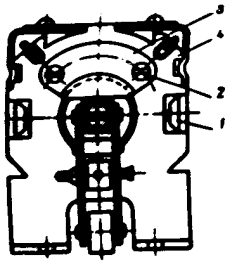
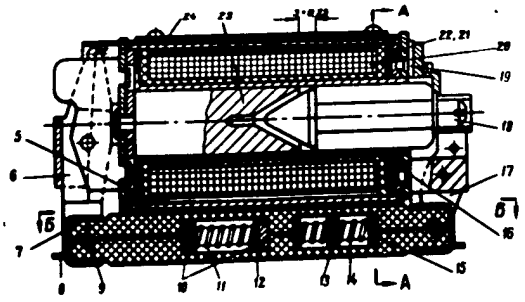
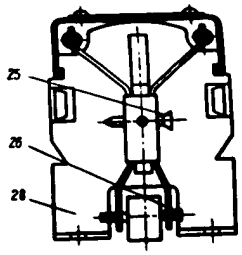


Fig. 42. PPT-40 Switch Panel
1 – bezel; 2 – elbow; 3 – axle; 4 – axle; 5 – panel; 6 – bushing; 7 – bushing; 8 – contact; 9 – rivet.

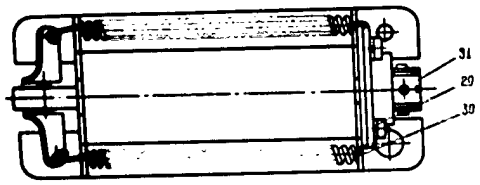


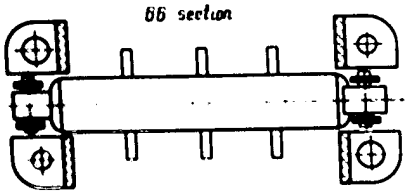






View of the relay without guard 27





AA section

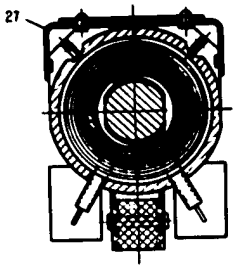


Fig. 44. PT-40 Relay Design
1 – casing; 2 – cover; 3 – supports; 4 – stands; 5 – washer; 6 – lever; 7 – carriage; 8 – spring; 9 – bushing; 10 – contact strip; 11 – spring; 12 – insulating washer; 13 – contact strip; 14 – spring; 15 – washer; 16 – sleeve; 17 – lever; 18 – core; 19 – gasket; 20 – coil; 21 – washer; 22 – washer; 23 – yoke; 24 – housing; 25 – lockpin; 26 – lockpin; 27 – guard; 28 – stand; 29 – spring washer; 30 – return spring; 31 – shaped nut.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

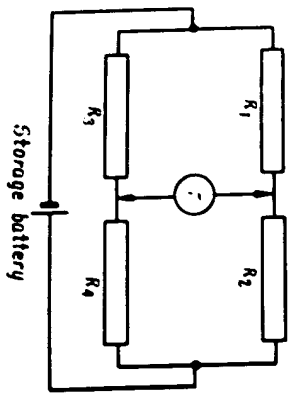


Fig. 46. Key Circuit for Checking the Transmitters on an Electric Plant
R_1 and R_2 – transmitter resistors; R_3 and R_4 – plant resistors; Г – zero galvanometer.

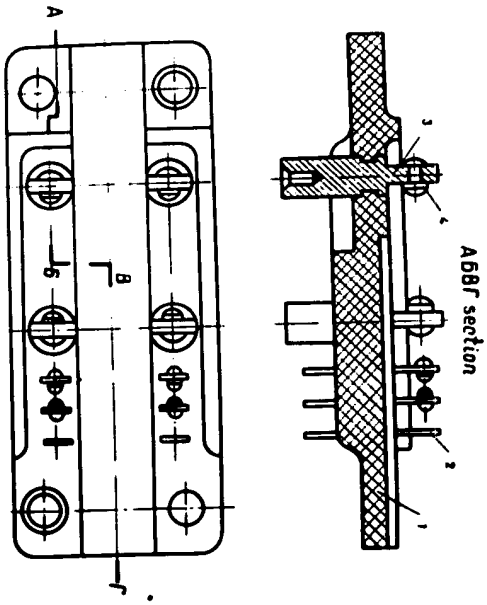


Fig. 45. PT-40 Panel
1 – panel; 2 – contact strip; 3 – contact stand; 4 – contacts.

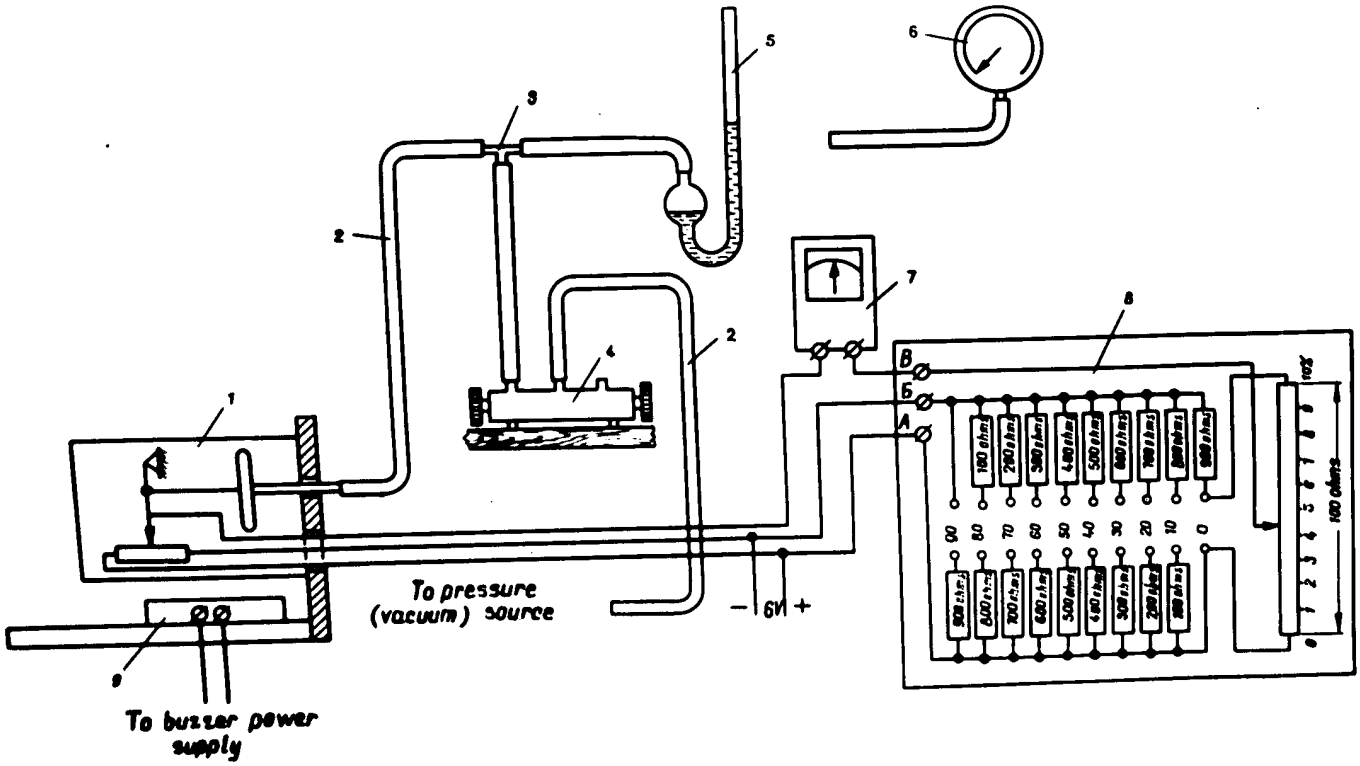


Fig. 47. Circuit for Testing and Calibrating the Transmitters
1 – sensed transmitter; 2 – rubber or durite hoses; 3 – T-piece; 4 – shut-off cock; 5 – mercury barometer; 6 – pressure gauge; 7 – zero galvanometer; 8 – electric plant.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

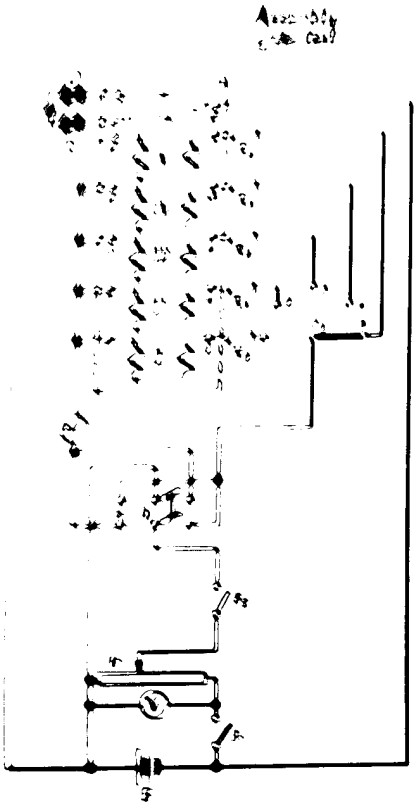


Fig. 48. Circuit for Checking the PTC Relay

[illegible] – storage battery up to 3 V; V – voltmeter up to 3 V; [illegible] – switches; mA – milliammeter with zero in the middle of the scale, up to [illegible] mA; [illegible] – potentiometer for 1000 ohms; R_2, R_3, R_4 [illegible] – wire resistors for 2500, 2500, 5000, 50 and 500 ohms, respectively.

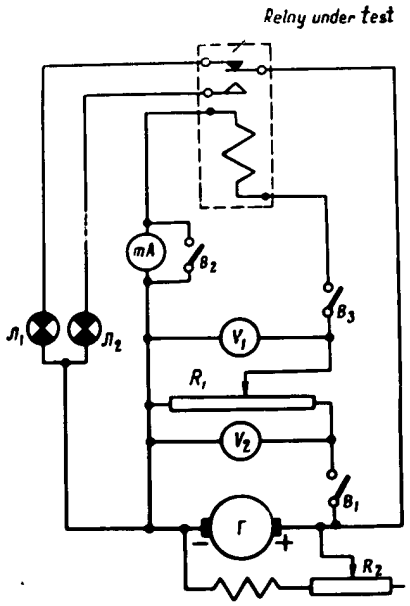
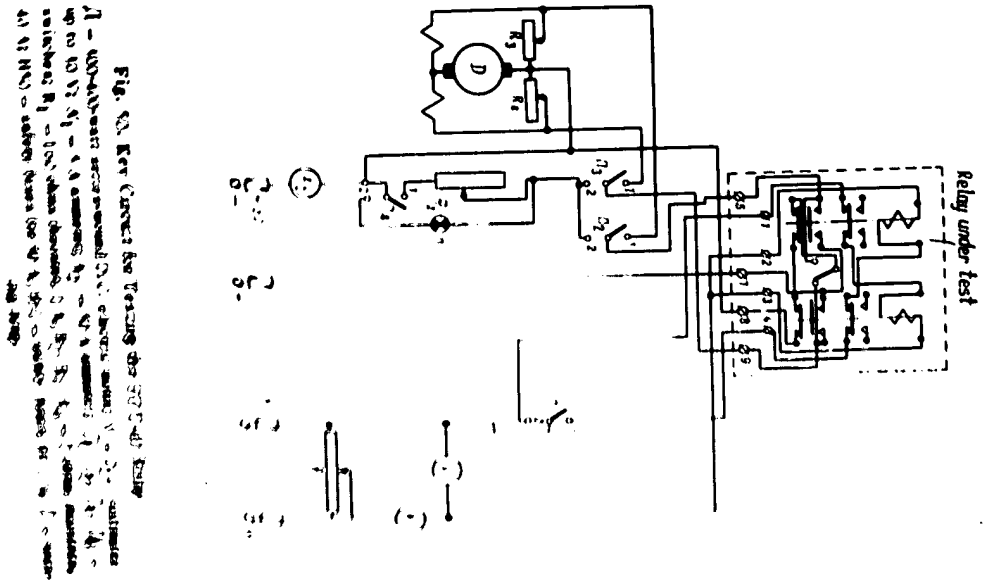


Fig. 49. Key Circuit for Testing the PC-3 Relay

Г – D.C. generator up to 30 V; V_1 and V_2 – D.C. voltmeters for 30 V; mA – milliammeter for 150 mA; $Л_1$, $Л_2$ – warning lamps; B_1, B_2, B_3 – switches; R_1 – potentiometer; R_2 – rheostat.



Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

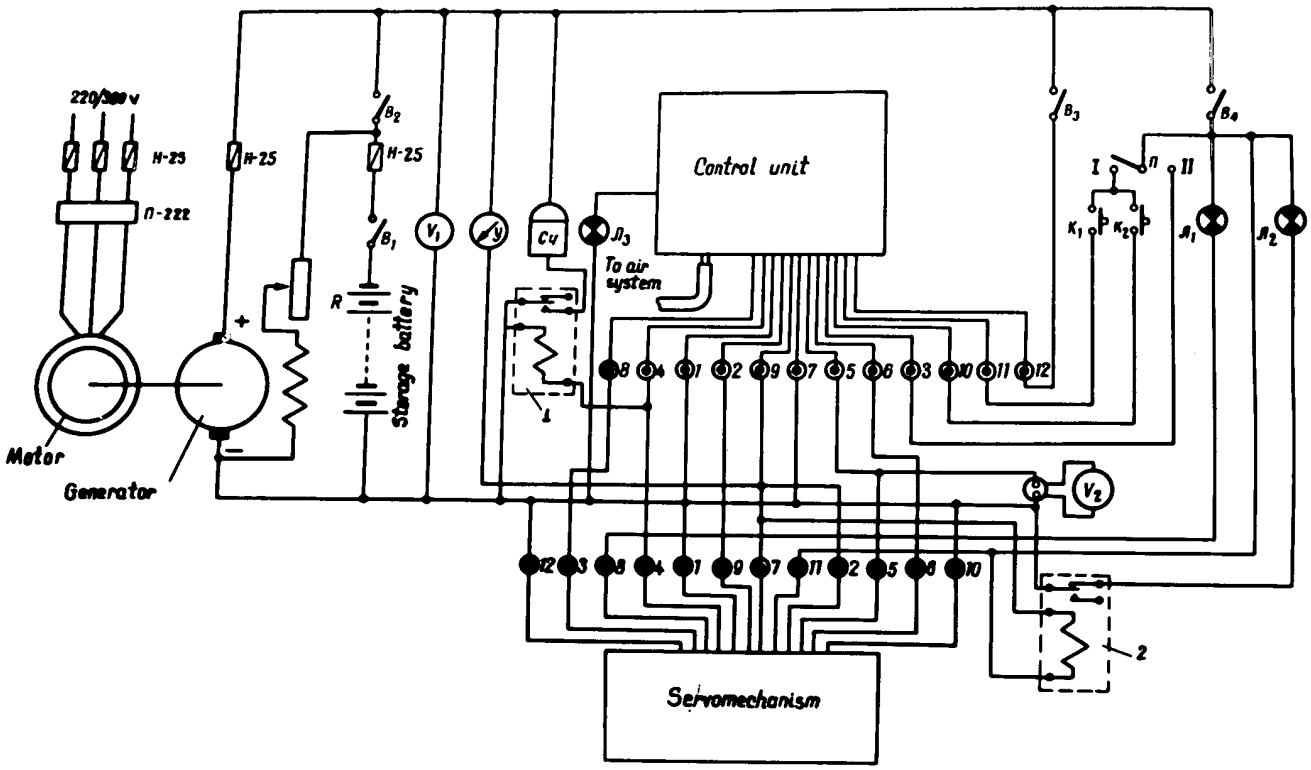


Fig. 51. Key Circuit for Testing АРУ-2А Automatic System

V_1 – 30 V D.C. voltmeter; V_2 – 15 V D.C. voltmeter; У – АРУ-2 position indicator; $C_Ч$ – counter of on-off positions; B_1, B_2, B_3, B_4 – switches; П – switch; $Л_1$, $Л_2$, $Л_3$ – warning lamps; K_1, K_2 – manual control push switches; R – 160 ohms rheostat, 1.5 A; 1, 2 – type РП-2 auxiliary relays; Н25 – safety fuses for 25 A; П222 – magnetic starter.

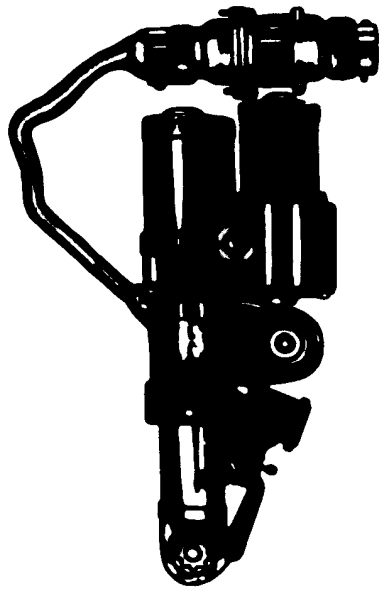


Fig. 53. АРУ-2А Servomechanism, Frontal View

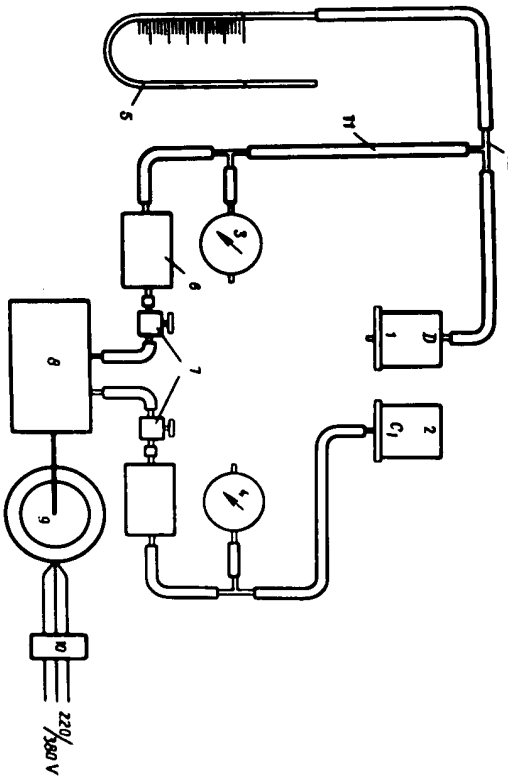


Fig. 52. Air System of the Control Desk

1 – МРД-106 transmitter; 2 – МРД-126 transmitter; 3 – speed indicator; 4 – altimeter indicator; 5 – mercury manometer; 6 – compensation tanks; 7 – shut-off cocks; 8 – vacuum pump; 9 – A.C. motor; 10 – magnetic starter; 11 – rubber or durite hoses; 12 – T-piece.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

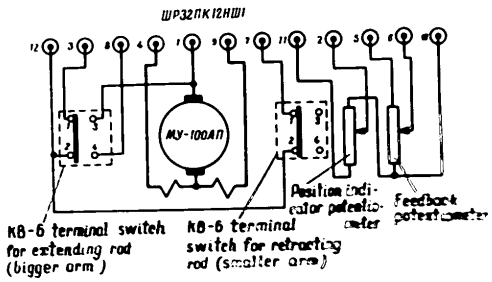
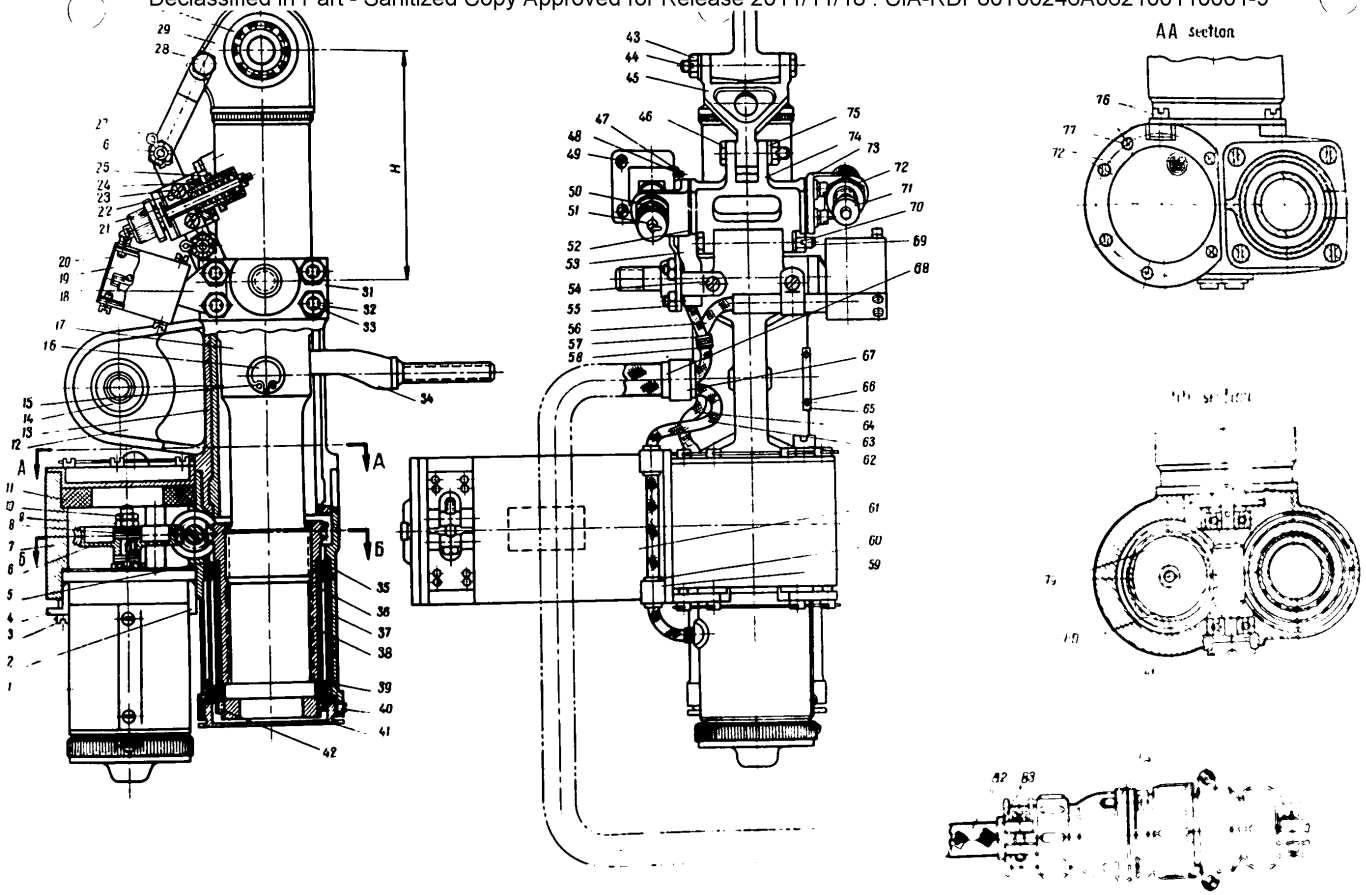


Fig. 54. APУ-2A Servomechanism, Electric Circuit

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9



1 — mismatch transmitter APU-2A; 2 — flange; 3 — screw; 4 — flange; [illegible] — washer; [illegible] — gear; [illegible]
10 — locknut; 11 — washer; 12 — upper bearing; 13 — bushing; 14 — [illegible]
18 — bracket; 19 — MM6 terminal switch; 20 — cap; 21 — [illegible]
cut; 27 — cutter [illegible]; 28 — bolt; 29 — rod head; 30 — ball bearing [illegible]
feel mechanism; 36 — washer; 36, 37 — distance bushings; 38 — [illegible] gear, [illegible]
43 — washer; 44 — slotted nut; 45 — crosspiece; 46 — bolt; 47 — [illegible] screw, [illegible]
adjusting shims; 51 — [illegible] sleeve, 54 — screw; 55 — bracket, [illegible] — screw [illegible]
57 — wires leading to the terminal switch for extending the [illegible]; 58 — cover; bearing, [illegible] — [illegible]
sleeve; 62 — screw; 63 — wires leading to the [illegible] transmitter; [illegible] — wires leading to the [illegible]
[illegible] — screw; 67 — collar; 68 — gasket; [illegible] — [illegible] — slotted nut; [illegible] — spring, [illegible]
75 — screw; 77 — screw; 78 — cover; 79 — ball bearing [illegible], [illegible] — washer, [illegible]

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

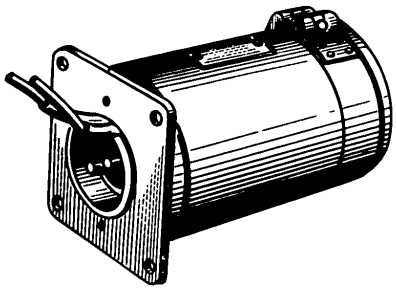


Fig. 56. МУ-100АП Electric Motor, External View

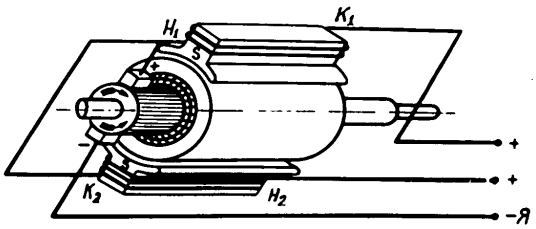


Fig. 57. МУ-100АП Electric Motor, Electric Circuit

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

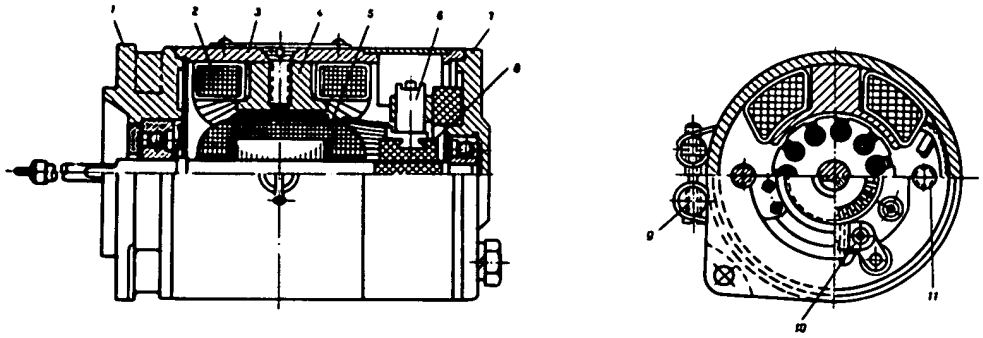


Fig. 58. MY-100AII Electric Motor Design

1 – front housing; 2 – coil; 3 – body; 4 – pole; 5 – armature; 6 – brush; 7 – rear housing; 8 – commutator; 9 – protective strap; 10 – brush-holder; 11 – coupling bolt.

Fig. 59. APY-2A Mismatch Transmitter, External View

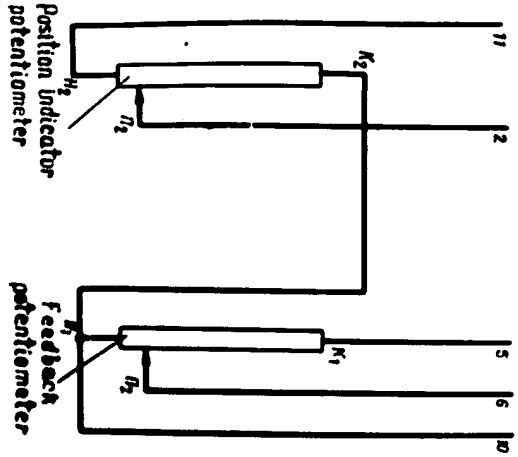


Fig. 60. APY-2A Mismatch Transmitter, Electric Circuit

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

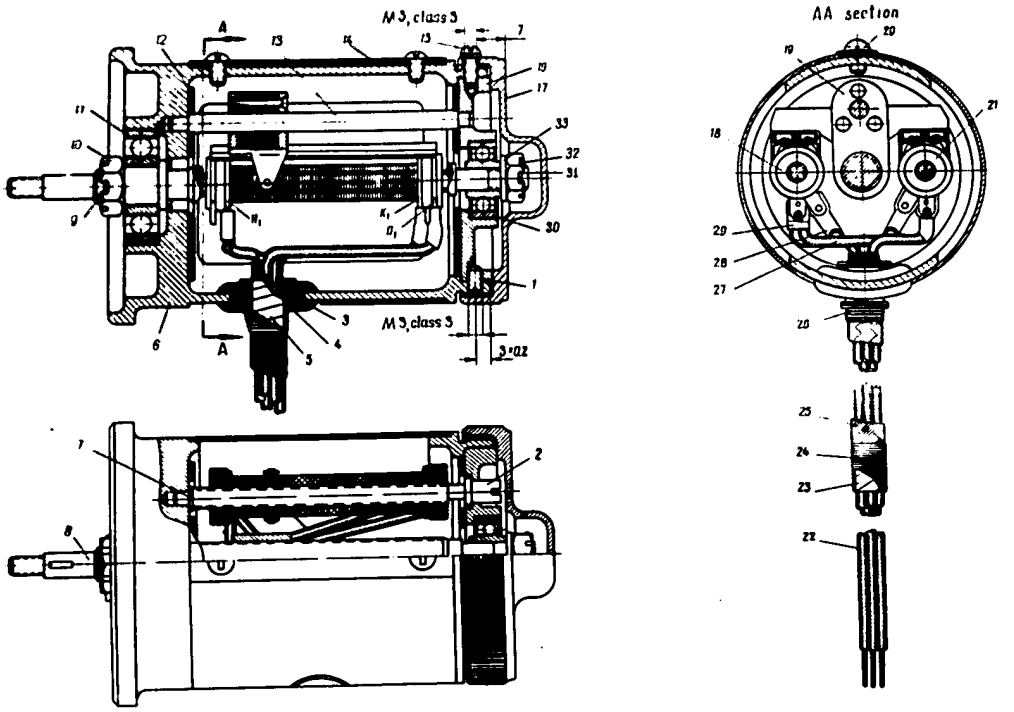


Fig. 61. APU-2A Mismatch Transmitter Design

1 – screw; 2 – axle ; 3 – cap; 4 – cotton banding; 5 – insulation; 6 – body; 7 – washer; 8 – axle; 9 – cotter pin; 10 – slotted nut; 11 – ball bearing 6008; 12 – gasket; 13 – axle; 14 – casing; 15 – screw; 16 – shield; 17 – cover; 18 – feedback potentiometer; 19 – contact block; 20 – screw; 21 – position indicator potentiometer; 22 – wire; 23 – insulation; 24 – cotton banding; 25 – shielding armoured braid; 26 – banding; 27 – wire; 28 – vinylchloride sleeve; 29 – vinylchloride sleeve; 30 – ball bearing 980055; 31 – cotter pin; 32 – slotted nut; 33 – washer.

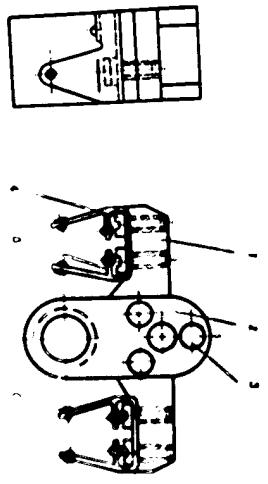


Fig. 64. Contact Block
1 – bracket; 2 – guide nut; 3 – rivet; 4 – [illegible]; 5 – [illegible]; 6 – contact.

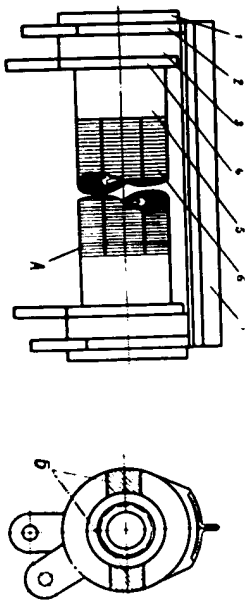


Fig. 63. Position Indicator Potentiometer
1 – washer; 2 – lug; 3 – washer; 4 – lug; 5 – former; 6 – winding; 7 – rod.

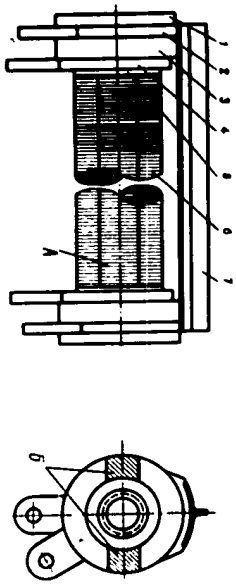


Fig. 62. Feedback Potentiometer
1 – washer; 2 – lug; 3 – washer; 4 – lug; 5 – former; 6 – winding; 7 – rod.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9 50X1-HUM

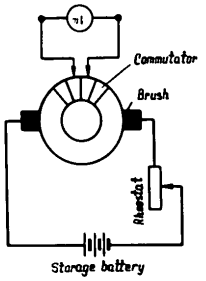


Fig. 65. Circuit for Checking the Electric Motor for Rupture and Short-Circuit

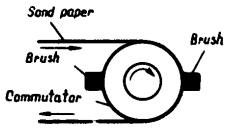


Fig. 66. Diagram for Lapping the Electric Motor Brushes

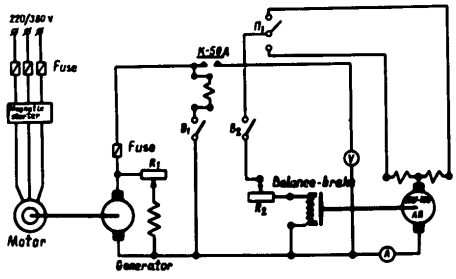


Fig. 67. Connection of the MU-100AP1 Electric Motor with the Instruments and Power Source

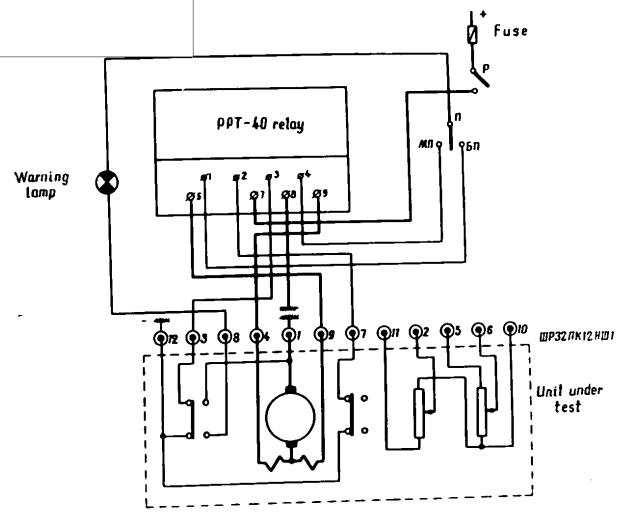


Fig. 68. Electric Circuit for Adjusting and Testing the APU-2A Servomechanism

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9
50X1-HUM

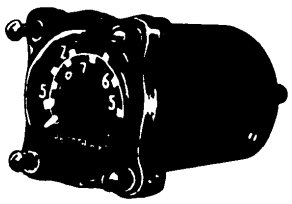


Fig. 69. APY-2A Position Indicator External View

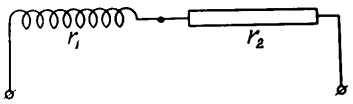


Fig. 70. Key Circuit of the Position Indicator
r_1 – operating winding; r_2 – series resistor.

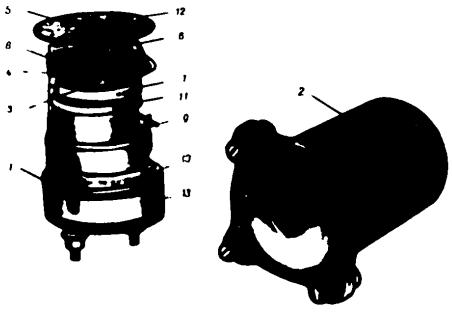


Fig. 71. Position Indicator Design
1 – base; 2 – steel housing; 3 – frame; 4 – axle; 5 – pointer; 6 – current-carrying spring; 7 – core; 8 – angle bracket; 9 – permanent magnet; 10 – magnetic circuit; 11 – pole shoe; 12 – scale; 13 – steel cover

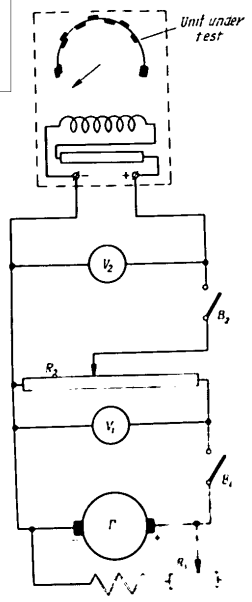


Fig. 72. Circuit for Checking and Calibrating the Position Indicator
Γ – 50 V D C generator; V_1 and V_2 – 50 V D C voltmeters; B_1, B_2 – switches; R_1 – rheostat; R_2 – potentiometer

SECRET
Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

50X1-HUM

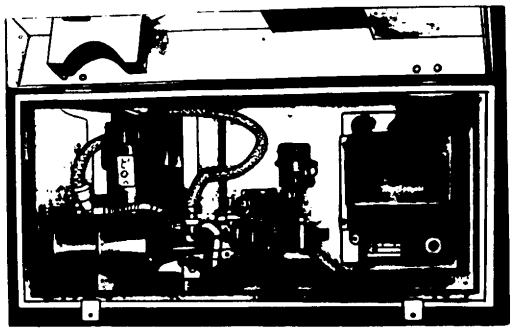


Fig. 73. External View of the Packed АРУ-2А Automatic System

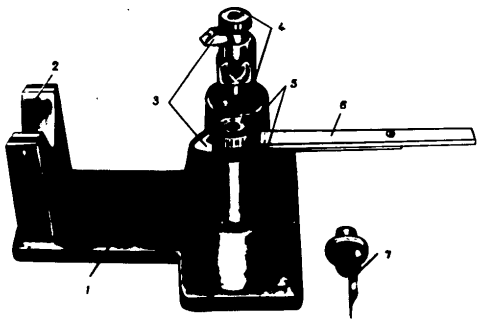


Fig. 74. Fixture for Testing the АРУ-2А Automatic Booster System
1 – plate; 2 – stand; 3 – lugs; 4 – wing nuts; 5 – studs; 6 – rule; 7 – pointer.

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9

50X1-HUM

Page Denied

Declassified in Part - Sanitized Copy Approved for Release 2011/11/18 : CIA-RDP80T00246A062100110001-9